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RESEARCH & DEVELOPMENT

PROJECT SUMMARIES

OCTOBER 1992

NAVAL TRAINING SYSTEMS CENTER
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This brochure presents brief summaries of the FY93 research efforts at the Naval Training Systems Center (NAVTRASYSCEN) in Orlando, FL. NAVTRASYSCEN has comprehensive simulation and training systems responsibilities ranging from research and technology base development through system acquisition and life cycle support. The NAVTRASYSCEN is unique in this integrated role because it performs research, specifies the training device's engineering, instructional, and operational requirements, selects the contractor, evaluates the trainer as it is being built, and ensures the trainer can be properly operated and maintained in the field. In addition to the Navy, NAVTRASYSCEN provides services for the Marine Corps, Army, Air Force, and foreign governments. The NAVTRASYSCEN's research mission is to plan and perform a full range of direoted research and development in support of Naval training systems for all warfare areas and platforms, to maintain an expanding technology base, and to transition research results to the fleet. R&D program emphasis is on fleet and training command requirements, rapid transition of products, industry/university coordination, improved planning, coordination with other services, and improved quality and cost effectiveness of products.

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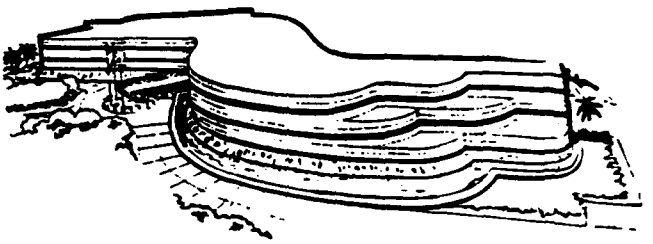
EXECUTIVE SUMMARY



The Naval Training Systems Center (NAVTRASYSCEN) has comprehensive simulation and training systems responsibilities, ranging from research and technology base development through system acquisition and life cycle support. The NAVTRASYSCEN is unique in this integrated role because it performs research, specifies the training device's engineering, instructional, and operational requirements, selects the contractor, evaluates the trainer as it is being built, and ensures the trainer can be properly operated and maintained in the field. In addition to its mission as the principal Navy activity for development of training systems, NAVTRASYSCEN provides services for the Marine Corps, Army, Air Force, and foreign governments.

The NAVTRASYSCEN's research mission is to plan and perform a full range of directed research and development in support of Naval training systems for all warfare areas and platforms, to maintain an expanding technology base, and to transition research results to the fleet. R&D program emphasis is on fleet and training command requirements, rapid transition of products, industry/university coordination, improved planning, coordination with other services, and improved quality and cost effectiveness of products. Needs for naval service training systems are determined by the warfare area sponsors for training and training systems under the Chief of Naval Operations and Chief of Marine Corps. These needs are generated by new weapon system developments, by modifications to existing weapon systems, and by fleet requirements for new training systems and capabilities to satisfy specific training tasks. Thus, the R&D program is balanced between improvements in highly specialized areas of simulation, training methods, training technology, and providing direct technical support to the training systems acquisition effort, especially in simulation engineering, instructional delivery methods, training cost reduction, demonstration of technology effectiveness, and the reduction of acquisition risk.

The majority of the work undertaken constitutes the Technology Base Program and includes exploratory development (6.2), where feasibility and conceptual research plans are determined, and advanced development (6.3A), where proof-of-concept is established. Additional efforts include cooperative/collaborative research with other government agencies, non-profit institutions, and commercial firms. Research funds are received from the Office of the Chief of Naval Research, Naval Air Warfare Center, the Joint Services Manpower and Training Systems Committee, Space and Naval Warfare System Command, the Air Force Human Resources Lab, and the Army Research Institute.

NAVTRASYSCEN has a long history of technology transfer to both the public and private sectors. NAVTRASYSCEN is involved with the school system and the Orange County Sheriff's Office to share information and expertise. Memorandums of Understanding exist with NASA, Kennedy Space Center, and the Federal Aviation Administration. There are currently five Cooperative Research and Development Agreements (CRADA). CRADAs provide for the transfer of technology developed in

federal government laboratories to the private sector. By sharing Navy training research, the public will benefit in having improved education and training. The Navy also receives valuable information in the exchange of information and resources.

The scientists and engineers in the Research and Engineering (R&E) Department at NAVTRASYSCEN work closely together to promote transitions of promising technology and to resolve problems that occur in acquisition programs or with fielded trainers. The two R&E divisions that conduct the majority of the research are:

Advanced Simulation Concepts Division - Conducts R&D on improvements to the fidelity, cost and training effectiveness of image generation and display systems for training; researches, develops, and tests new concepts in low cost computer-based simulation; conducts R&D on multiplatform connectivity using DoD distributed interactive simulation network protocol; conducts R&D related to providing the physical stimuli that simulate the operational equipment; performs and directs computer applications research for warfare operations related training systems to improve training capabilities and cost effectiveness; and operates and maintains shop facilities to fabricate, repair or modify experimental mechanical and electro-mechanical devices for use in R&D projects.

Human Factors Division - Develops and advances the basic knowledge required to provide the foundation for human factors applications to training systems; and conducts laboratory and field research to determine the degree to which new technology may be applied in the design of innovative training systems.

This brochure presents brief summaries of the FY93 research efforts at NAVTRASYSCEN. Its purpose is to inform anyone who has an interest in training simulation technology of the research being performed at NAVTRASYSCEN. For more information on the individual tasks, please call or write the principal investigator shown with each task. Copies of this brochure and summaries of each individual task are available from the Defense Technical Information Center (DTIC). The DTIC accession number is provided for each task that has a work unit summary on file. For information on obtaining copies from DTIC, call or write to:

Defense Technical Information Center
Office of User Services and Marketing
Bldg. 5, Cameron Station
Alexandria, VA 22304-6145
(202)274-6434/AUTOVON 284-6434

The brochure is organized as follows:

- Advanced Development
- Exploratory Development
- Independent Research and Independent Exploratory Development
- Joint Services R&D Program
- Small Business Innovative Research
- Tasks funded by other Navy activities
- Technology Transfer

ADVANCED DEVELOPMENT - 6.3A

The objective of this program is to conduct proof-of-concept demonstrations, risk reduction developments, and cost-effectiveness investigations in simulator and training technology. It improves mission effectiveness and safety by applying knowledge about human learning to engineering design of training systems. This advanced development program is a continuing effort to improve fleet readiness through development, demonstration, and transition of simulation and training device technology to acquisition programs. In recent years, along with significant increases in the complexity of weapons systems, have come increasing requirements for more advanced simulation and training technology.

The program is based on requirements established by the Chief of Naval Operations (CNO). It is designed to improve the integration of technologies that support weapons and training system development, including all aspects of the research, development and acquisition process from technology development and demonstration, to systems requirements analysis, design, test and evaluation, and support for deployed systems. The program is organized around specific demonstration tasks that target critical technical risks that confront future weapons system acquisition programs. The demonstration tasks are carefully selected to focus attention on a problem and a solution, and to complement significant R&D investments made in the simulation industry.

The simulation and training devices program entails a balance between "technology push" and "requirements pull." The focus of the program is on demonstrations of technology for a wide variety of applications, from portable part-task trainers up to and including fullscale high-fidelity weapons system simulations, and battle-force combat simulations.

NAVTRASYSCEN has four advanced development efforts, which are described on the following pages.

AIRCREW COORDINATION TRAINING

Principal Investigator - C. Prince
Code 26 Phone: 407/380-4831
DTIC Agency Accession Number: DN700014

BACKGROUND: Aircraft incidents and accidents caused by human error in the cockpit provide compelling justification for the introduction of more effective aircrew training. Recently, the proportion of incidents and accidents attributed to human error is estimated to be between 60% and 80%. Analysis of these errors reveals that they are not due to a lack of technical knowledge in how to fly a plane, but to failure of the pilot to optimize cockpit resources, particularly aircrew resources. Poor aircrew coordination compromises not only flight safety but also effective mission performance. These two factors, safety and performance, have resulted in a new emphasis on training in cockpit resource management, particularly in response to unusual situations. The aviation industry and military have responded to this need by developing crew coordination programs, but little effectiveness research has been conducted.

OBJECTIVE: The objectives of this work are to develop an integrated, validated methodology for training crews in coordination, develop a proof-of-concept training system, and to establish specifications for aircrew coordination training and for evaluation of that training. This work builds on the aircrew coordination framework and instructional technologies developed under the 6.2 Aircrew Coordination and Performance task.

BENEFITS: The operational benefits from this task will be an improved aircrew coordination resulting in increased mission effectiveness and reduced accident rates in all manned airborne weapons systems. Prevention of a single aircraft accident attributable to poor crew coordination will provide significant return on investment based on the cost of the program compared to saving even a single aircraft.

STATUS: Three prototype programs have been completed and turned over to representative communities in the fleet (H-46 in Norfolk and New River, CH-53 in Tustin, V-22 to Bell Boeing). The T-44 program has been delivered in an initial form and both the A-6 and F-14 programs are being developed. These two programs will represent more closely the final methodology and recommendations, since they include integration in the current curriculum. The evaluation of the H-46 program has been conducted with the Navy, and the CH-53 validation effort is ready to begin as soon as the simulator comes back on line. Workshops have been conducted with all Marine aviation

communities to assist them in developing an interim program that will transition easily into the programs they will receive in 2-3 years. Navy workshops were conducted. Guidelines and draft specifications for the development of ACT based on the NAVTRASYSCEN methodology are being completed.

MAJOR MILESTONES:

Phase I Module Demonstrations	FY91
Phase I Evaluation Report	FY91
Phase II Module Demonstrations	FY92
Phase II Evaluation Report	FY93

FORWARD DEPLOYABLE AVIATION SIMULATOR TECHNOLOGY

Principal Investigator - A. Rodemann
Code 25 Phone: 407/380-8345
DTIC Agency Accession Number: DN702028

BACKGROUND: Aircrews deployed on aircraft carriers lack a facility for recurrent training in critical flight skills and for conducting mission rehearsal exercises. These deployed aircrews must utilize operational aircraft to enhance and maintain skills since current training facilities are confined to large shore based installations. The use of operational aircraft is expensive, provides only limited training opportunities for advanced weapons procedures, and does not provide a significant mission rehearsal capability. The simulator industry does not have test beds to demonstrate integrated multisource components or to evaluate the training effectiveness of the advanced training hardware it develops. The Navy's aviation simulation test beds can demonstrate the feasibility of new design concepts and reduce the risk associated with integrating these concepts.

OBJECTIVE: The objective of this effort is to develop design guidelines for deployable aircrew trainers for critical flight tasks and mission rehearsal. This task will provide integrated demonstrations of key technology components which present risk areas critical to the success of transition to the Deployable Tactical Aircraft Training System (DTATS) planned for FY94. These areas include low cost reconfigurable cockpits and threat simulations for deployed applications, helmet mounted visual displays, simulator networking for interactive crew coordination, and cost effective photo-based image generators.

BENEFITS: Evaluation of advanced technology components will substantially reduce the cost and risk of acquiring DTATS. Furthermore, the hands-on experience provided to aircrews will greatly facilitate the refinement of the performance requirements for DTATS.

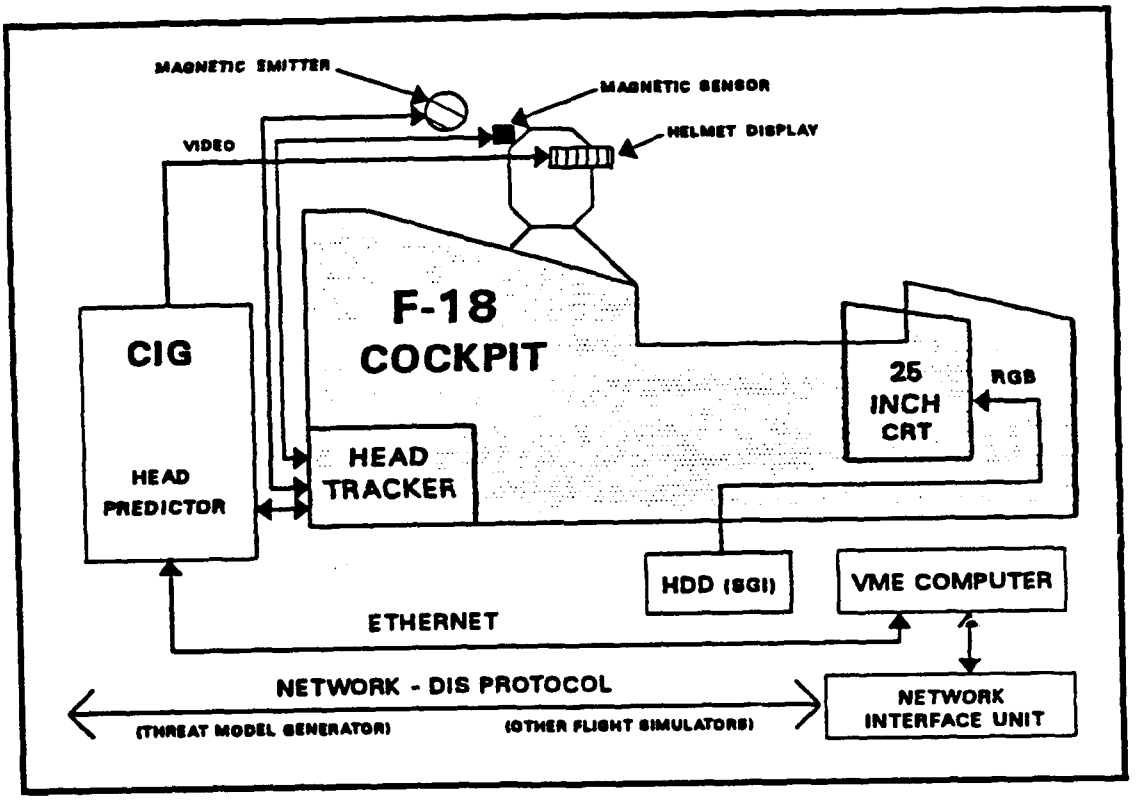
STATUS: The Tactical Environment Simulation has been installed and is operational through a Network Interface Unit. The computer system and hardware for the F/A-18 cockpit is up and running. A new and faster head-tracker has been procured and has been integrated with the helmet-mounted display and the image generator. Prediction algorithms for providing image stability with observer head motion have been installed and are being evaluated. Scaling and boresight procedures are being implemented. New databases have been formatted and added to the library.

The baseline configuration for the simulation was extensively evaluated by a F/A-18 pilot who is an instructor as well as an Operation Desert Storm veteran. The effects of haze and fog on the out-of-the-cockpit visual was implemented. Additional performance data has been obtained to drive the threat simulation.

The Tactical Situation Display has been improved and rehosted on a VAX screen eliminating the need for one CRT. The capability to use a PC based system for debriefing exercises conducted on the baseline configuration is being implemented.

MAJOR MILESTONES:

Mission Rehearsal Support Capability	FY93
Classified Exercises (Networked)	FY93
Tactical Environment Simulation Data Base	FY93
User Friendliness	FY93
TAMPS Integration	FY93
Full System Demonstration and Evaluation	FY93



FORWARD-DEPLOYABLE AVIATION SIMULATION TECHNOLOGY (FAST)

ORGANIC COMBAT SYSTEMS TRAINING TECHNOLOGY

Principal Investigator - R. Stratton
Code 25 Phone: 407/380-4587
DTIC Agency Accession Number: DN701012

BACKGROUND: Shorebased training systems for shipboard combat systems have become prohibitively complex and expensive, and do not contribute to readiness to a degree sufficient to warrant their cost. To reduce training costs and increase readiness, the Navy recently established the Afloat Training Command (ATC). In the future, tactical training which was formerly conducted at shorebased sites, will be done aboard ship under the control of the ATC. This is a major change to the training continuum and makes the ship the cornerstone for combat systems, damage control, and hull, mechanical and engineering training. For combat systems training, this new approach will require all major combatants to be equipped with a combat systems embedded training capability. This embedded training capability will have to accommodate multi-warfare as well as multi-ship training. Because of the large number of ships involved, the per ship cost for the embedded training capability will have to be kept low for the new strategy to be affordable.

OBJECTIVE: The overall objective of this effort is to find ways to reduce the costs associated with shipboard embedded training systems and demonstrate the results. "Cost" in this context refers not only to direct dollar cost for acquisition, but also to other costs such as logistic costs, operational costs, manpower costs associated with operation and support, and other costs not as visible as acquisition costs.

BENEFITS: This task will develop low cost combat systems embedded training technology that will support the Navy's new approach to training. The products will be in the areas of scenario generation and control, combat system simulation and stimulation, performance measurement and feedback, and multi-ship connectivity using the DoD Distributed Interactive Simulation (DIS) network protocol.

STATUS: The approach chosen to develop the low cost technology was to select an existing Navy training system that had most of the required capabilities, redesign and repackage it using modern off-the-shelf technology, and in the process drastically reduce physical size and cost. The training system selected for downsizing was the Pierside Combat System Team Trainer (Device 20B5) for the FFG-7 class Frigate. The 20B5 software is being rehosted from Gould 3287 to non-proprietary Motorola 88000 micro-computers. Hardware and software redesign of the Device 20B5 Instructor/Operator Station using X Terminals was completed in FY92. Integration of the rehosted 20B5 simulation system with the FFG-7 Combat Direction System is underway. A capability to process messages using DIS protocol has been developed and integrated into the simulation system.

MAJOR MILESTONES:

Single Ship Tactical Environment Embedded Training	FY92/FY93

Instructional Features Demonstration	FY93
Performance Measurement and Evaluation System Dev, Test & Eval, and Demonstration	FY93
Demonstrate Networking Capability	FY93
Multi-ship Capability Demonstration	FY94

Combat Information Center Mockup

CARRIER-BASED WEAPONS SYSTEM TRAINER

Principal Investigator - A. Rodemann
Code 25 Phone: 407/380-8345

DTIC Agency Accession Number: TBD

BACKGROUND: The continual introduction of sophisticated military equipment into the arsenals of third world countries will ensure that future threats arrayed against naval aviation will be of the most advanced technology. Naval aviation's use of increasingly complex aircraft, sensors, weapons and tactics against skillful adversaries in widely diverse scenarios increases the need for creative training techniques to assure mission success. Due to a deficiency of training ranges, weapons and real world training constraints, weapon systems training is rarely available to carriers and forward deployed units. Additionally, accomplishments with mission-preview systems during Operation Desert Storm suggest mission rehearsal will substantially improve the probability of "first pass" mission success. To sustain vital combat skills while deployed and to increase the probability of first pass mission success, simulated weapons employment training and air strike mission rehearsal must be continuously accessible to carrier and forward deployed aircrews.

OBJECTIVE: The objective of this Advanced Technology Demonstration is to provide proof of principle of helmet-mounted display (HMD) systems as part of a tactical aircraft weapon system simulation capable of deployment aboard a carrier for mission rehearsal of night and day strike missions. The program deals with critical high risk technologies needed to respond to the current deficiency of adequate complex weapon practice and mission rehearsal during deployment. The task is designed to transition directly to the Navy Deployable TACAIR Training System (DTATS) in FY96.

BENEFITS: Evaluation of advanced technology components will substantially reduce the cost and risk of acquiring DTATS. Furthermore, the hands-on experience provided to aircrews will greatly facilitate the refinement of the performance requirements for DTATS.

STATUS: This is a new start for FY93. Initial start-up funding was provided in FY92 and this was used to initiate the effort in the photo imagery area. Also in FY92, a HMD was purchased under the Forward-Deployable Aviation Simulation Technology task and transferred to be used in field of view evaluations.

MAJOR MILESTONES:

HMD Development	
Night HMD	FY93
Day HMD	FY94/FY95
Evaluations	FY93/FY94/FY95
Photo Imagery	FY93/FY94/FY95
Image Enhancement	FY93/FY94
Dynamic Stability	FY94
Sensor Compatibility	FY95

EXPLORATORY DEVELOPMENT - 6.2

The objective of this program is to provide mission support technologies essential for all naval operations through the development of training device simulation technology. The Office of Naval Technology mission area for training systems is concerned with improving the training effectiveness of Navy training devices, lowering their costs, and extending training device applicability into more training domains. The technology being developed will enhance visual and sensor simulation capabilities, provide advanced computer hardware and software concepts for greater real-time simulation capabilities, improve the instructional value of simulation systems, and define the necessary functional characteristics of training devices.

NAVTRASYSCEN has four exploratory development projects. Two projects, Instructional Technology and Simulation Technology, are divided into tasks. The individual tasks and the remaining two projects are described on the following pages.

AIRCREW COORDINATION AND PERFORMANCE

Principal Investigator - C. Prince
Code 26 Phone: 407/380-4831
DTIC Agency Accession Number: DN709006

BACKGROUND: The coordinated performance of aircrews for mission safety and success has become an issue of concern for military training. Research has shown problems stemming from insufficient skills in effective management of cockpit resources. Accident and incident investigation has revealed that 60-80 percent of all accidents are caused by problems with decision making, leadership, judgment, communication and crew coordination. Improved training of aircrews in task coordination is necessary for crew performance effectiveness, air combat maneuvering, and operational readiness. Current aircrew training emphasizes specific, necessary skills and is not designed to provide experience with crew coordination. This research effort will identify crew coordination factors that lead to effective performance, as well as the factors that contribute to a failure of coordination. Emphasis will also be placed on the need for standardized, objective, and relevant aircrew performance measurement as a natural corollary to the aircrew training issue.

OBJECTIVE: Objectives of this task are to define and assess aircrew coordination skills, develop performance measures indicative of crew performance, and develop technology to support training.

BENEFITS: This effort will provide: (a) a framework to guide and focus Navy aircrew coordination training research; (b) determination of instructional technology relevant to aircrew coordination training; (c) procedures and tools to assess and measure crew coordination; and (d) methods for performance assessment and evaluation in aircrew coordination training. These products will transition to the 6.3 Aircrew Coordination task, which is developing and validating proof-of-concept aircrew coordination training modules. Aircrew training is costly, but is not nearly so expensive as an absence of training or training that is inefficient. This task can introduce greater efficiency into the aircrew coordination performance area by determining: 1) the requirements of coordinated performance; 2) the obstacles to that performance that arise both from human factor design deficiencies and training needs; 3) diagnostic measures to determine specific training needs; 4) training methods that are designed to address specific problems; and 5) performance measures for aircrew coordination. The results can directly impact all multi-seat operational systems.

STATUS: The performance observation scale developed by NAVTRASYSCEN for aircrew coordination has been subjected to a multi-trait, multi-method analysis. Results indicate that raters can discriminate skills from one another and that they can agree on skill ratings for crews. An experiment on feedback for specific aircrew coordination behaviors has been conducted and the data are presently being analyzed. Pensacola intermediate student pilots were involved in research with the table-top trainer to determine the appropriateness of experiential ACT at their level. Responses of the students were overwhemingly positive about the experience. Data from the various projects where scenarios were used are being reviewed to determine the consistency with which the skill behaviors can be elicited. This

requires consideration of the opportunities for decision making and for the use of procedures in particular that are included in the scenarios.

MAJOR MILESTONES:

Demonstration of Expert System	FY91
Report of Results/Recommendations	FY92
Transition to Advanced Development	FY94/FY95

RETENTION OF TRAINED SKILLS

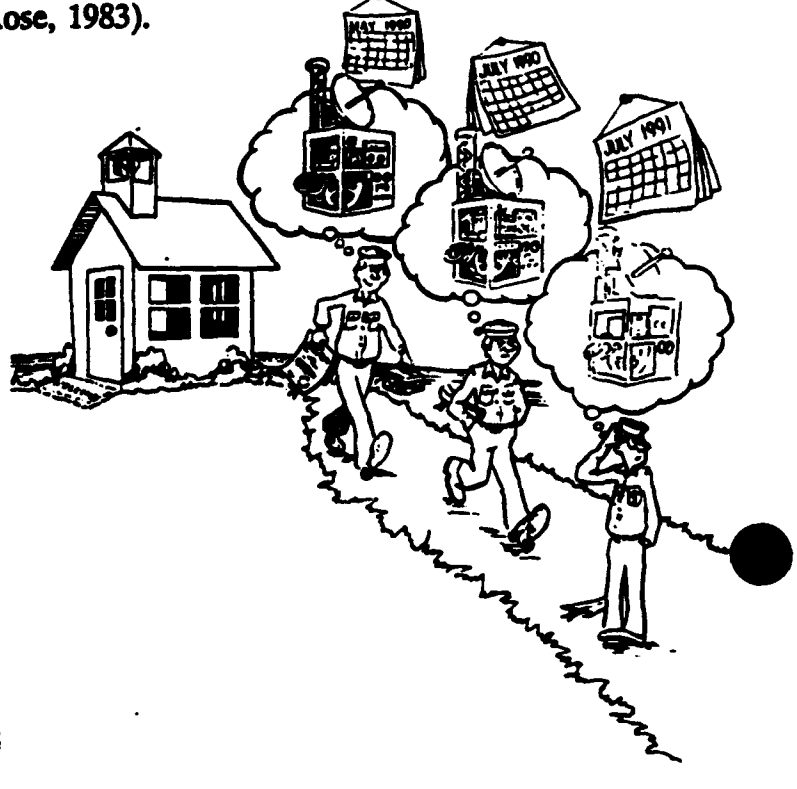
Principal Investigator: K. Ricci
Code 26 Phone: 407/380-4661
DTIC Agency Accession Number: DN702025

BACKGROUND: Even the most effective training program cannot ensure that trainees will be able to perform on the job if they do not retain the skills they have learned. This is especially problematic for perishable skills such as complex procedural tasks, tasks that are seldom practiced, or for reservists, who only train during brief and intermittent periods. Although considerable research has been conducted on skill retention, most training effectiveness evaluations are not able to longitudinally track trainees to determine how long and how well skills are retained after training. Additional information is needed on the effects of task parameters, amount and distribution of practice, use of training devices and simulators, instructional techniques, conditions of transfer, individual differences, and other variables on skill retention. Information is also needed to develop performance measures that can be used to predict operational performance.

OBJECTIVE: To develop guidance for improved training device and training simulator design, more effective and efficient methods for use of these devices, and ways to improve performance measurement methods for use in predicting operational performance and to improve skill retention.

BENEFITS: Information on the variables affecting skill retention will help in the development of training devices, simulators, and instructional techniques, which can efficiently maximize the retention of critical skills. Such information, together with predictive performance measures, will also enable the Navy to target personnel who need refresher training to maintain criterion levels of operational readiness and will provide information on the design of refresher training. This retention of skills has been identified as a serious problem in the Navy and DoD (Schendel, Shields, Katz, 1978; Vineberg, 1975; Ellis, 1979; Hagman and Rose, 1983). However, there is currently a limited knowledge about the retention of skills (Hagman and Rose, 1983).

STATUS: Following a review of the skill retention literature, two areas have been identified for further research: complex cognitive skills and team skills. Experimental facilities are being established to study cognitive skills and testing will begin in FY93. Critical incident interviews will be conducted to further define issues in team skill retention. Experimental facilities will be established and testing will begin in FY93.



MAJOR MILESTONES:

Establish Facility	FY92
Conduct Experiments	FY93
Technical Report	FY94

EMBEDDED TRAINING TECHNOLOGY IDENTIFICATION AND DEVELOPMENT

Principal Investigator: R. Ahlers
Code 26 Phone: 407/380-8569
DTIC Agency Accession Number: DN708021

BACKGROUND: Shorebased trainers have limitations, among them: training sites often do not conform to any platform's unique configuration of equipment and software; there are a limited number of sites; trainers often simulate only a portion of the equipment normally found on-board, with reduced fidelity simulation of some elements; and personnel are removed from their normal duty station for extended periods of time. Planners have increasingly emphasized embedded or organic shipboard training systems as the method to overcome the limitations of shorebased training.

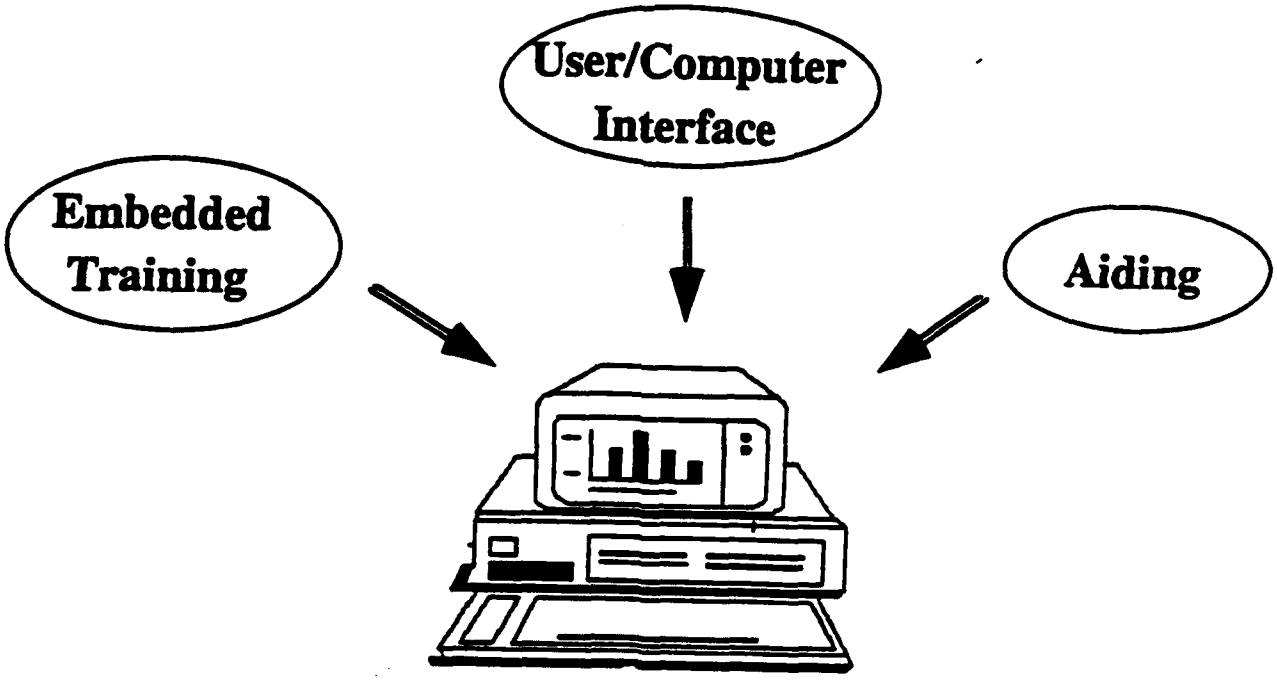
OBJECTIVE: To advance the understanding of requirements for embedded operator and tactical team training systems, and also suggest immediate improvements that can be incorporated into embedded training that is currently under development, evaluation, or already fielded.

BENEFITS: Embedded training (ET) will provide training in all warfare areas to individual operators, to tactical decision makers, to sub-teams and ultimately to full combat system teams operating in coordinated efforts in multi-threat warfare. State-of-the-art training technology will make ET programs true training systems. This effort will suggest immediate improvements that can be incorporated into currently fielded ET. Up to 80% of the cost of a training program is consumed by the delivery of instruction to trainees. These costs, which can exceed $200K per course for each student, can be reduced by improving the efficiency and effectiveness of the training. This can be realized by improving the instructional elements of training systems, by applying technology such as that developed in this task.

STATUS: A technique for cognitively engineering the instructional content of L-TRAN lessons and an adaptive sequencing strategy were evaluated. Enlisted Navy students and experienced operational personnel at the Fleet Combat Training Center, Pacific were used as subjects. Results were positive in supporting the value of the cognitive engineering approach. The techniques are being further evaluated at the Aegis Training Center. An effort to integrate the roles of ET with decision aiding has entered a second phase. The integration methodology is being implemented as a software tool (IDATES) to test the robustness of the methodology. The use of ET in instructor/operator consoles to teach the operation of the training system is being investigated. Preliminary designs for on-line help are to be evaluated using instructor tasks and training system prototypes developed in-house. A computer-based presentation of ET research findings and guidelines for their application will be implemented as a software tool for design engineers. This presentation will be evaluated to determine if it is an efficient means for technology transfer. Alternate display formats for presenting feedback on trainee performance are being developed and evaluated.

MAJOR MILESTONES:

Technical Report, Evaluation of Cognitive Structured Lessons	FY92
Technical Report, Embedded Instructor Training in Trainer Operator Consoles	FY92
Demonstration, Intelligent Platform and Runtime System	FY92
Demonstration, Software Tool for Design Engineers	FY93



INSTRUCTIONAL PROCESSES FOR SITUATIONAL AWARENESS

Principal Investigator - D. Baker
Code 26 Phone: 407/380-4792
DTIC Agency Accession Number: TBD

BACKGROUND: Situational awareness has been identified as a critical construct in aviation performance and is likely to be a critical variable in other settings. For example, situational awareness has been posited to be an important component of effective aircrew performance, particularly in combat situations. Despite its importance, situational awareness is a concept that has not been developed in terms of the theoretical underpinnings that contribute to this construct. This lack of research has limited the extent to which instructional strategies and performance measurement tools can be developed to further investigate the situational awareness construct.

OBJECTIVE: To conduct situational awareness research to identify the critical underlying individual and team components, develop instructional strategies, and develop performance measurement tools.

BENEFITS: Research on the variables underlying situational awareness will help in the development of effective instructional strategies for training both individual and team-level situational awareness, as well as impact the proficiency of performing other team and individual level skills. This effort will also result in effective performance measures for training feedback and performance criterion development. Information from this research will have a direct impact on human performance research, in general, as well as have implications for a number of variables in cognitive psychology, such as self-monitoring behaviors.

STATUS: This is a new start. In FY93, existing literature on situational awareness and relevant areas of cognitive psychology will be surveyed, resulting in a documented literature review. In addition, critical individual and team-level situational awareness behaviors will be identified along with appropriate instructional strategies for training these behaviors. This information will be embedded in a theoretical framework of the situational awareness construct to guide the research. A testbed community will be identified and experimental hypotheses generated.

MAJOR MILESTONES:

Phase I - Generate Theoretical Framework	FY93
Phase II - Develop Measures	FY94
Phase II - Conduct Experiments	FY94
Phase III - Provide Guidelines	FY95

TRAINING TECHNOLOGY FOR DISTRIBUTED SYSTEMS

Principal Investigator - D. Dwyer
Code 26 Phone: 407/380-4139
DTIC Agency Accession Number: TBD

BACKGROUND: There is a growing movement in the surface community to deliver combat systems training on board ship rather than in shore-based facilities. Afloat Training Organizations (ATOs), newly formed to support this movement, will rely almost exclusively on ship-board training for combat systems teams (both pier-side and at sea). These organizations will emphasize coordinated multi-warfare, battle force level training scenarios. To accomplish this training, ships, the teams that train on them, and instructional support personnel must be networked to form a distributed training system. This shift in training delivery will require evaluation of current training strategies and supporting systems. Within the past year, research has been conducted to identify performance differences between distributed and non-distributed systems. Results suggest team processes are impacted within a distributed system.

OBJECTIVE: Objectives are to investigate the type of decisions made at all levels of distributed teams, develop technologies to support automated performance assessment of the decisions and their implementations in distributed teams, and develop design guidelines to provide instructional support in distributed training.

BENEFITS: This effort will provide instructional guidelines, principles, and recommendations for employing battle force level exercises associated with Distributed Interactive Simulation (DIS), such as the Battle Force Tactical Training System and the Tactical Combat Training System, and for support of ATOs. Information about instructional factors impacting distributed systems and ATOs, along with behavioral skills and performance measures, will allow simulated exercises to be transformed into efficient ship-based training within the context of composite warfare command doctrine. It also will add valuable technology applicable to all training environments, on shore and at sea.

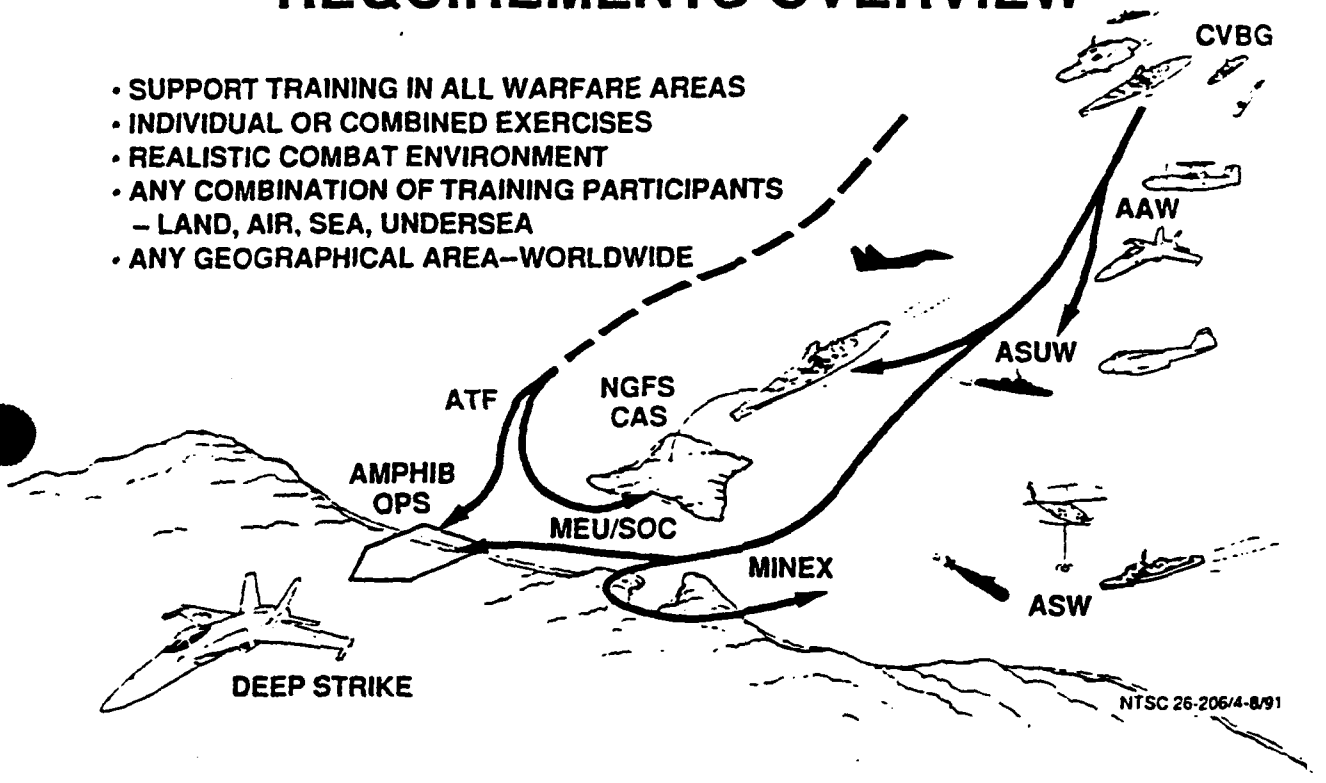
STATUS: This is a new start. In FY93, existing literatures impacting distributed systems and ATOs will be reviewed to identify current design guidelines and efficiencies. A detailed research plan with testable hypotheses addressing distributed system processes and ATOs will be generated. The requirements for a research test facility will be documented and existing facilities that meet the requirements will be identified, if feasible.

MAJOR MILESTONES:

Develop Research Plan	FY93
Establish Research Facility	FY94
Conduct Experiments	FY94-96

TCTS OPERATIONAL PERFORMANCE REQUIREMENTS OVERVIEW

- SUPPORT TRAINING IN ALL WARFARE AREAS
- INDIVIDUAL OR COMBINED EXERCISES
- REALISTIC COMBAT ENVIRONMENT
- ANY COMBINATION OF TRAINING PARTICIPANTS
  – LAND, AIR, SEA, UNDERSEA
- ANY GEOGRAPHICAL AREA–WORLDWIDE



SUBMARINE EMPLOYMENT TRAINING

Principal Investigator - R. Ahlers
Code 26 Phone: 407/380-8569

DTIC Agency Accession Number: TBD

BACKGROUND: On-the-job experience continues to be relied upon to integrate basic skills learned in Navy schools. This experience is typically unguided, differs unsystematically for each individual, and often does not lead to satisfactory job performance. Formal operator training focuses on **how** to operate complex equipment but does not impart a knowledge of the purpose of various features and operational modes. Employment training (training in the effective employment of system capabilities) should fill the gap between formal operator training ("knobs and dials") and tactical team training, either at-sea or in a training simulator. The technologies used to support the two types of training have proven difficult to integrate, and many difficult issues must be resolved before an effective employment trainer can be designed.

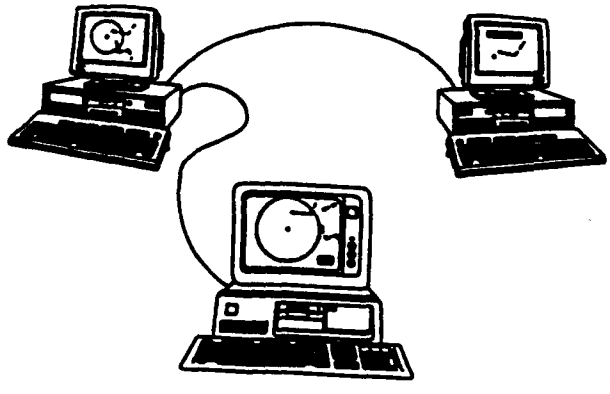
OBJECTIVE: The objective is to develop and evaluate training techniques which will facilitate the development of an understanding for equipment operation. An emphasis will be placed on providing a student with a set of tools which will allow the exploration of a simulation environment. Two testbeds will be used: a periscope skills trainer for analyzing simpler skills and a networked part-task tactics trainer for investigating more complex cognitive skills.

BENEFITS: The technology developed in this task will be widely applicable to various training domains. Operators will better understand their equipment, and consequently team training will be more effective. Shipboard training, where little instructor assistance is available, is a good candidate for the technology because of its increased focus on embedded instructional features. The current reliance on shore-based team training systems utilizing expensive tactical equipment will be significantly reduced.

STATUS: This is a new start. In FY93, a periscope skills training testbed will be completed, instructional support features will be developed, and initial evaluation experiments at the NAVSUBCOLNLON will begin.

MAJOR MILESTONES:

Demonstration, Periscope Skills Trainer	FY93
Evaluation, Instructional Paradigms	FY94
Demonstration, Networked Part-Task Tactics Training Testbed	FY94
Evaluation, On-Line Student Tools	FY96



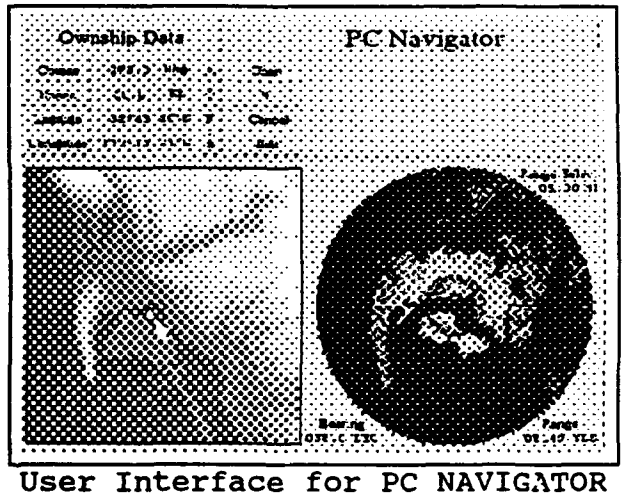
SIMULATION OF ADVANCED SENSORS

Principal Investigator - J. Allen
Code 25 Phone: 407/380-4579

DTIC Agency Accession Number: DN708025

BACKGROUND: The advanced development and increased use of such sophisticated sensors as thermal imaging and imaging radar have significantly expanded the capabilities of military platforms. Sensor technology developments have contributed both to safer and more effective operations and tactics. These gains in capability, however, can only be realized fully through effective training programs. One of the challenges facing simulation today is the creation of cost effective simulations of advanced sensor systems for training high data rate/workload conditions found in both aircraft and shipboard operation. Current personal computer technology offers the potential for providing a low cost surface navigation training aid if appropriate radar and other electronic navigation aids can be simulated. Traditionally, radar simulation requires special hardware (target generators, etc.) which may not be required to teach rudimentary skills or demonstrate basic navigation concepts. Research will demonstrate a low cost personal computer based interactive surface navigation training aid that significantly augments traditional classroom and high fidelity simulator based training.

OBJECTIVE: To improve surface navigation training by developing an appropriate PC based simulation of radar and other electronic navigation aids.



User Interface for PC NAVIGATOR

BENEFITS: This task will provide design approaches and laboratory demonstrations of PC based radar and other electronic navigation aids simulations. Introduction of this new technology into classrooms will provide instructors with a new classroom tool which can be used to illustrate and dramatize fundamental surface navigation concepts. By providing a presentation tool for the instructor and a visual focal point for students, abstract concepts can begin to take on more meaning and navigation procedures learned as a series of discrete steps become more intuitive. Theoretically, any world-wide coastal area supported by Defense Mapping Agency (DMA) data in CD ROM format will be available for simulation. Semi-automated, area-specific data base generation techniques will provide quick turn-around methods of database generation. On board ship, less experienced members of the navigation team may benefit from its use as a concept review tool. A more robust version might be used for harbor familiarization.

STATUS: A preliminary software based radar navigation training package that operates on a PC system has been demonstrated. An evaluation prototype version of the software package, PC NAVIGATOR, was integrated and delivered to QM "A" School at Service

School Command, Naval Training Center, Orlando. A second package was requested by and sent to the Navigation School at Fleet Training Center, Norfolk. Insertion into school curriculum at NTC Orlando is probable. Interest has been shown by both Coast Guard and Naval Reserves. A CRDA with private industry is pending. A funding shortfall in FY92 prevented any further evaluation or changes to the existing software prototype. The accompanying figure depicts the present user interface. A representation of the area navigation chart is displayed on the left with a real time simulation of a navigation radar display to the right.

MAJOR MILESTONES:

Install development model at QM "A" School	FY91
Preliminary evaluation model delivered to QM "A" School	FY92

CIG COST/PERFORMANCE ENHANCEMENT

Principal Investigator - J. Booker
Code 25 Phone: 407/249-3122
DTIC Agency Accession Number: DN708026

BACKGROUND: Aircraft trainer systems have recently been incurring costs for the visual simulation system in the range of one-third of the total system costs. The technical problem is to develop techniques which will reduce the cost of Computer Image Generation (CIG) visual simulation systems while maintaining or improving performance.

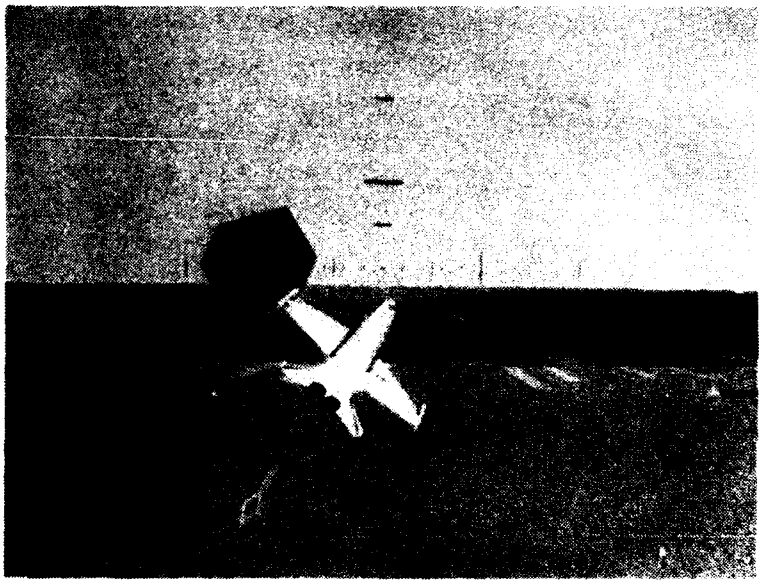
OBJECTIVE: The objective is to reduce the cost of CIG visual simulation systems while maintaining or improving performance. Demonstrations of utilization of low cost workstation CIG systems will establish a trend of cost reductions in high end, high performance CIG systems.

BENEFITS: This effort will develop and demonstrate techniques which will reduce cost and improve performance of CIG visual simulation systems in future training devices. Both low cost workstation technology hardware and interactive database development software techniques will be explored to provide low cost options. Currently, CIG system hardware costs are running $1M to $2M per channel for training simulator systems. New graphics workstation technology-based systems should cost under $100K per channel.

STATUS: Low cost CIG workstation technology results were used to derive design guidelines and specification inputs for the visual system for the Philippine Navy shiphandling trainer. Three SBIR phase I contracts were completed. The accompanying photo is a scene taken from a real-time program running on an IRIS workstation.

MAJOR MILESTONES:

Barge Ferry/Pilot Coxwain Trainer Specs	FY91
Shiphandling Trainer Specs	FY92
Low-cost CIG Specs	FY93
Evaluate Automated Database	FY93
Transition to 6.3	FY94



ACTIVE SONAR MODELING

Principal Investigator - L. Healy
Code 25 Phone 407/380-4590
DTIC Agency Accession Number: DN700011

BACKGROUND: The Navy has an urgent need for on-board operator training in the use of low-frequency active (LFA) sonar for identification and tracking of submarine targets. The change in the military threat from global conflict to regional conflict and from nuclear submarines operating in the deep ocean to diesel submarines operating in shallow water puts added emphasis on the use of active sonar. Training in the use of LFA sonar requires (1) means to provide a realistic representation of the operator displays, and (2) training methods that teach the operator to relate the operator displays to the physical situation.

The key element in providing operator training is the generation of realistic displays that provide appropriate representation of the submarine maneuvers in the shallow ocean environment. The displays must then be related to the maneuvers and the ocean characteristics to provide the student with an understanding of the relationship.

OBJECTIVE: The objective of this task is to synthesize the high-fidelity LFA displays necessary for training and to incorporate these displays and to demonstrate these displays in interactive courseware for on-board operator training.

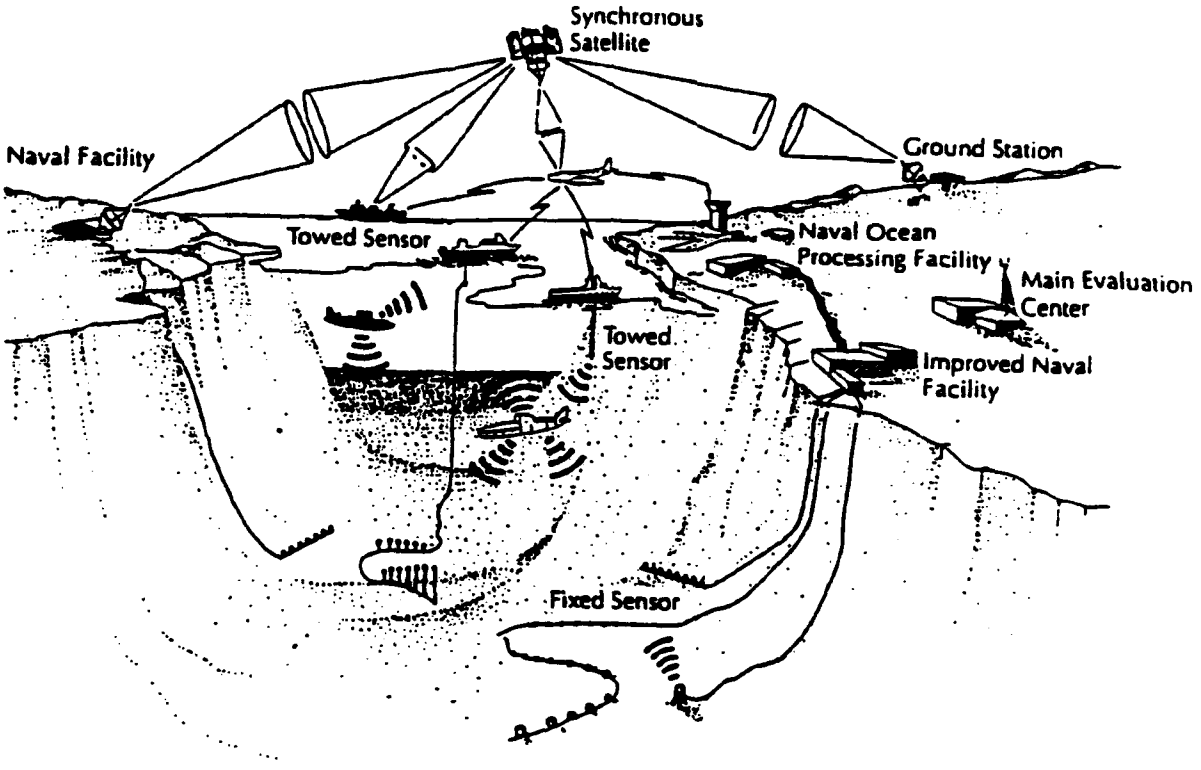
BENEFITS: Benefits derived from this research include: (1) significant improvement in the training of LFA sonar operators and their ability to interpret the acoustic displays, (2) ability to use standard Navy desktop computers to provide ASW operator training, and (3) techniques and data bases which can be incorporated into larger and more complex training systems.

The near term results of this research effort will contribute to the introduction of LFA sonar into the undersea surveillance community. The immediate use this research will be development of a course for on-board training of acoustic operators at Integrated Undersea Surveillance System (IUSS) sites. The results will provide realistic scenarios incorporated in tabletop trainers using personal computers, thereby allowing students to observe the change in the ASW display as a result of operator actions. The methods and techniques will apply equally to training aboard ship both underway while deployed and while in home port.

STATUS: Active sonar modeling for LFA is a new topic. Previous work in the development of displays for the AN/SQS-53A surface sonar provide a basis for the new work in LFA.

MAJOR MILESTONES:

Basic Lesson for Baseline ICW	FY94
LFA Operator Display Modeling Report	FY95
Baseline Interactive Courseware Report	FY96
Courseware Using LFA Modeling	FY96



ACTIVE SONAR MODELING

MOVING WEAPONS SIMULATION TECHNOLOGY

Principal Investigator - A. Marshall
Code 25 Phone: 407/380-4653
DTIC Agency Accession Number: DN702026

BACKGROUND: Technology currently available to provide simulator environments that allow machine gun training from moving vehicles and aircraft without live rounds or firing ranges is insufficient. The technical problems are: development of a low-cost miniature motion platform to support the gunner and the weapon; development of the equations of motion; development of a means of simulating tracers and explosions in 3-D and the development of more accurate means of determining weapon aiming position.

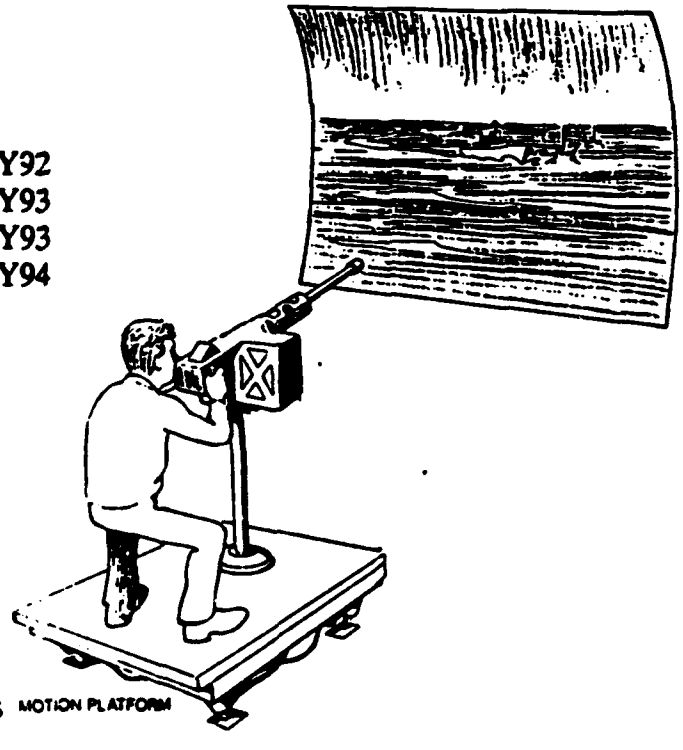
OBJECTIVE: The objectives are to develop technology to simulate tracers and explosions and the visual background that appear in 3-D to the trainee; develop the technology to more accurately determine weapon pointing location required by the very accurate 50-cal machine gun; develop the technology for low-cost/small motion platforms; determine the training effectiveness of the simulator and the efficacy of the motion platform; develop the ballistic equations for moving platforms; and to develop a research model. Research the efficacy of the use of 3-D in trainers.

BENEFITS: This technology will be used to develop trainers to teach gunners to fire machine guns from the following moving platforms: Riverine Water Craft Humvee, Dune Buggies, etc., and Helicopter Door Gunnery Trainers. The trainers will negate the use of real vehicles which will save money on fuel and wear and tear on helicopters and land vehicles. Special firing ranges will no longer be required. In many locations and countries the firing of live machine gun rounds is not permitted. The trainers will be able to more accurately score and determine why a trainee is missing the target.

STATUS: A 3-D display system was investigated and is partially working. A tracker has been designed and fabricated.

MAJOR MILESTONES:

3-D Effects	FY92
Motion Platform Completed	FY93
Fabricate Research Model	FY93
Report	FY94



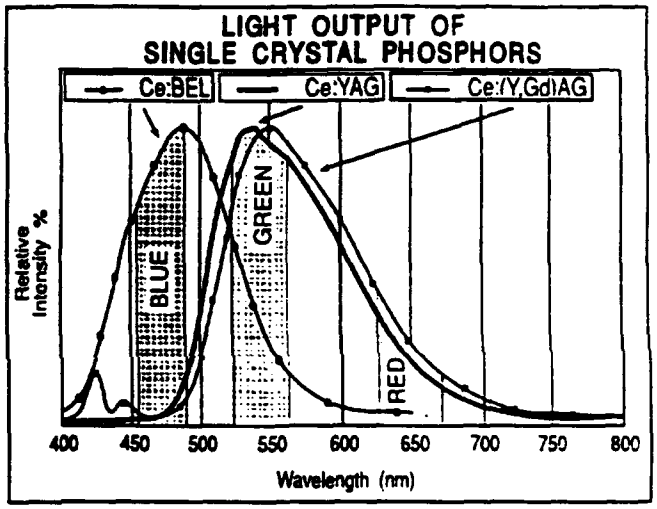
26 MOTION PLATFORM

CRYSTAL TARGET PROJECTOR

Principal Investigator - R. Hebb
Code 253 Phone: (407)-380-4578
DTIC Agency Accession Number: DN709009

BACKGROUND: A low cost, high resolution and brightness color projector is needed for visual simulation systems such as flight simulators, air traffic control trainers, ship docking trainers, helmet mounted displays and night vision goggle simulation. Presently only high cost light valve projectors can provide reasonably adequate resolution and brightness. Recent significant advances in CRT faceplate technology give the development of a low cost, high resolution/brightness projector a good chance of success.

OBJECTIVE: The objective of this task is to develop and test an improved video projector using single crystal faceplate technology. Theory indicates that the development is feasible.



BENEFITS: Development of this new state-of-the-art projector will provide better image brightness and resolution than currently available for less cost and will allow a smaller projector footprint.

STATUS: External light output from single crystal phosphors has been increased by forming a pyramidal facet structure on the epitaxial phosphor layer grown on the single crystal CRT faceplate. This pyramidal structure, which re-directs otherwise lost light, was formed by the photolithographic application of a hexagonal masking layer with subsequent acid etching to form facets in the crystal phosphor. Several sets of Ce:YAG single crystal phosphor faceplates to be used in the construction of evaluation CRTs have been delivered. Also delivered were two sets of faceplates for blue output (Ce:BEL) and for red output (Ce,Gd:YAG) that will be tested for efficiency and color characteristics.

Under a contract for the design and construction of a high performance video projection brassboard, two 2-inch faceplates have been integrated into suitable CRT envelopes for evaluation of the single crystal faceplates. These CRTs were tested in a high performance video projector testbed, yielding a peak faceplate brightness of 62,700 FootLamberts (net light output of 435 Lumens from a 1-inch square raster).

Attempts at constructing CRTs from larger 3 inch faceplates revealed inadequacies with the initial CRT envelope design related to thermal expansion mismatch. New methods

of constructing the CRTs, using a gradient quartz thermal expansion matching technique, were researched and used to construct CRTs from the 3 inch faceplates. Initial testing of these new CRTs show good envelope integrity. Characterization measurements are underway with completion scheduled by the second quarter of FY93.

MAJOR MILESTONES:

Testing of 3-inch diagonal Ce:YAG Single Crystal Faceplates	FY92
Testing of Ce:BEL and (Ce,Gd):YAG Single Crystal Faceplates	FY93
Demonstration of Projector Brassboard in a Dome Screen	FY93
Begin lifetime testing of Ce:YAG CRT	FY93

TACTICAL TRAINING INSTRUCTOR COMPONENTS (TACTICS)

Principal Investigator - B. Pemberton
Code 25 Phone: 407/380-4602
DTIC Agency Accession Number: DN700009

BACKGROUND: New concepts are required for effective utilization of tactical training systems of the 90s. A ten-fold increase in the total number of tracks currently simulated for tactical training systems is a requirement. However, no corresponding increase in the number of training system instructors to generate or control training system scenarios using this increased number of tracks is anticipated. The TACTICS task is investigating two new concepts to meet the increasing demand on tactical training system instructors: automatic scenario generation, and automatic scenario control.

OBJECTIVE: The objective is to investigate two concepts and develop two demonstration systems -- 1) Automatic Scenario Generator (ASG), and 2) Automatic Scenario Control (ASC). The ASG objectives are to reduce instructor's time and effort for scenario setup. and make the user-machine interface easy to use. The objectives of the ASC are to reduce instructor workload, allow instructor to monitor more information, and provide real-time performance measurement and feedback.

BENEFITS: Fleet readiness and mission effectiveness will be enhanced with the automation of the instructor training system functions. Results of this research will provide rapid development and operation of training system exercises that are representative of operational events. The time required to create a typical scenario will be reduced from 6 weeks to 1 week. The amount of information required to specify a scenario will be reduced by over 90%. During control of scenarios, instructors will be provided multiple windows to increase the amount of information monitored, automatic warfare advisors to increase instructor response to rapidly changing tactical situations, and automatic performance measurement and feedback to provide timely evaluations of exercise successes.

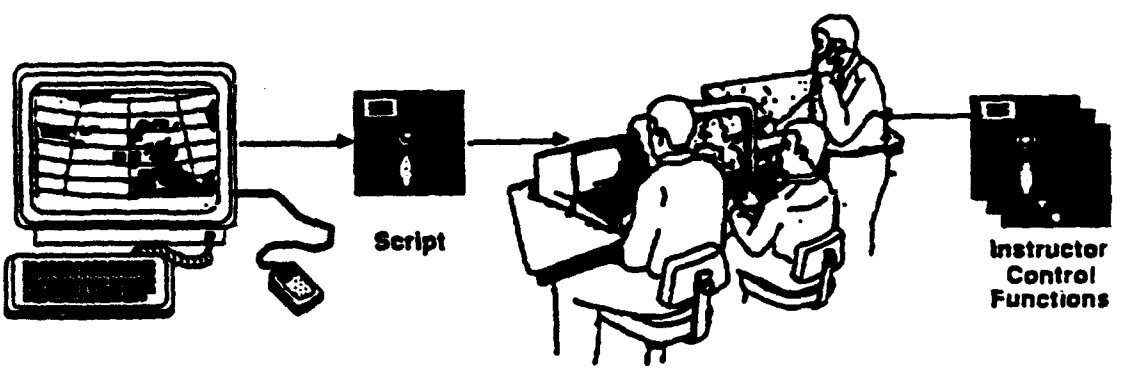
STATUS: A contract was awarded for TACTICS ASG for battle force/group embedded training. A graphical direct manipulation user interface for scenario preparation for ASW training has been designed and implemented. Scenarios are built on a selected geographical area of the World Vector Shoreline data base from the Defense Mapping Agency. An editing function has been included to permit the easy addition of underwater contours. A spinoff effort, TACTICS scenario preparation and control, developed demonstration software to automatically script orange forces as a front-end addition to NPRDC's Batman & Robin software (NAVAIR/NTSC Small Business Innovative Research Phase I).

MAJOR MILESTONES:

Technology Workshop (TACTICS -- Using Expert Systems for Training)	FY92

MAJOR MILESTONES (cont'd):

Prototype ASW interactive scenario editor	FY92
Demonstration of Automatic Training Exercise Force Lay-Down Decision Aid for Embedded Training	FY93



Tactical Training Instructor Components for the '90s --

Automatic Scenario Generator and Automatic Scenario Control

ADVANCED COMPUTING APPLICATIONS

Principal Investigator - R. Soeldner
Code 25 Phone: 407/380-8202
DTIC Agency Accession Number: DN702027

BACKGROUND: There is a continuing need for high performance, low-cost computing for simulation in general, and training devices in particular. Some of the current problems which could be resolved with high performance computing are data visualization for instructor and students, complex battle force simulations, intelligent computer-directed adversaries, simulation of missing combat team members, intelligent computer-based tutoring, and many forms of animated displays. On the other hand there are a number of high performance computing elements, such as math coprocessors, digital signal processors, array processors, superscalar and pipeline architecture processors, graphics processors, and a myriad of parallel processors available on the open market which could be directly applied to these problems. For instance, the addition of a math coprocessor to a personal computer significantly increases the performance of the computer when used to solve scientific problems. Despite this, there has been little use of these computer technologies in resolving computer simulation problems. The reason for this seems to be the specialized programming required to effectively use these devices and the lack of library software directed toward simulation.

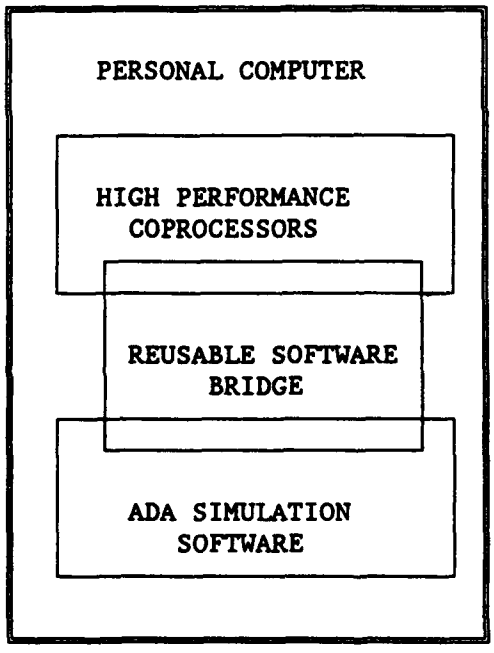
OBJECTIVE: The purpose of this task is to explore the possibility of extending the math coprocessor concept to the use of other high performance processors in the solution of simulation problems, by embedding highly iterative algorithms in the coprocessors and isolating implementation detail through the use of reusable Ada specifications.

BENEFITS: If this task can successfully demonstrate the feasibility of this concept, it could open the door to many low-cost computer simulation applications considered to be impractical because of computer run times. This task coupled with the Reusable Ada Repository for simulation, currently under development for NAVTRASYSCEN, will provide a vehicle for widespread use of the products of this and follow-on efforts.

STATUS: An Ada specification defining 22 procedures has been completed. The Ada specification was developed using the reusability guidelines developed for the reusable simulation software repository. An Ada body which supports the Ada specification and an Ada test program which exercises the procedures of the Ada specification have also been completed. A statistical profiler is being used to run the Ada test program and provide baseline performance data. The Ada specification has also been implemented in C and assembly language and some relative performance data has been gathered. Making an Ada interface to the Vector Processor which will transparently load the coprocessor and provide the necessary software hooks is taking longer than expected but is progressing. Initial performance experiments are still expected to be completed by the first quarter of FY-93.

MAJOR MILESTONES:

Initial Performance Experiments	FY93
A practical simulation problem involving ocean acoustics and requiring high performance computing will be implemented	FY93
Demonstration involving the data visualization of multidimensional ocean acoustic data	FY94



SONAR PROCESSOR SIMULATION

Principle Investigators - G. Fraas/Dan Paterson
Code 25 Phone 407/380-4797 or 8564
DTIC Agency Accession Number: TBD

BACKGROUND: Fleet SONAR operators are not fully utilizing the capabilities of their SONAR system. Operators are currently trained **how** to operate equipment, but not trained **when** and **why** to perform certain tasks. Training to increase knowledge of environmental effects and how an individual SONAR interacts with the environment needs to be improved. This has led to increased emphasis for a concept known as "SONAR employment" training. This training is expected to fill the gap between basic operator training (knobology) and tactical team training.

OBJECTIVE: The objective of this task is to develop technology to simulate the onboard SONAR processing.

BENEFITS: The ability to simulate onboard SONAR processing with medium to high fidelity will significantly reduce the cost for multi-seat advanced operator/employment trainers. The same modeling techniques will be relevant for air and surface platforms. The output from this effort will be a systematic approach to specifying and developing multi-beam SONAR simulations, with the ability to size the models to the desired fidelity. In addition, a full simulation will facilitate future integration with embedded performance measurements and other data required to support real-time SONAR employment instructional capabilities.

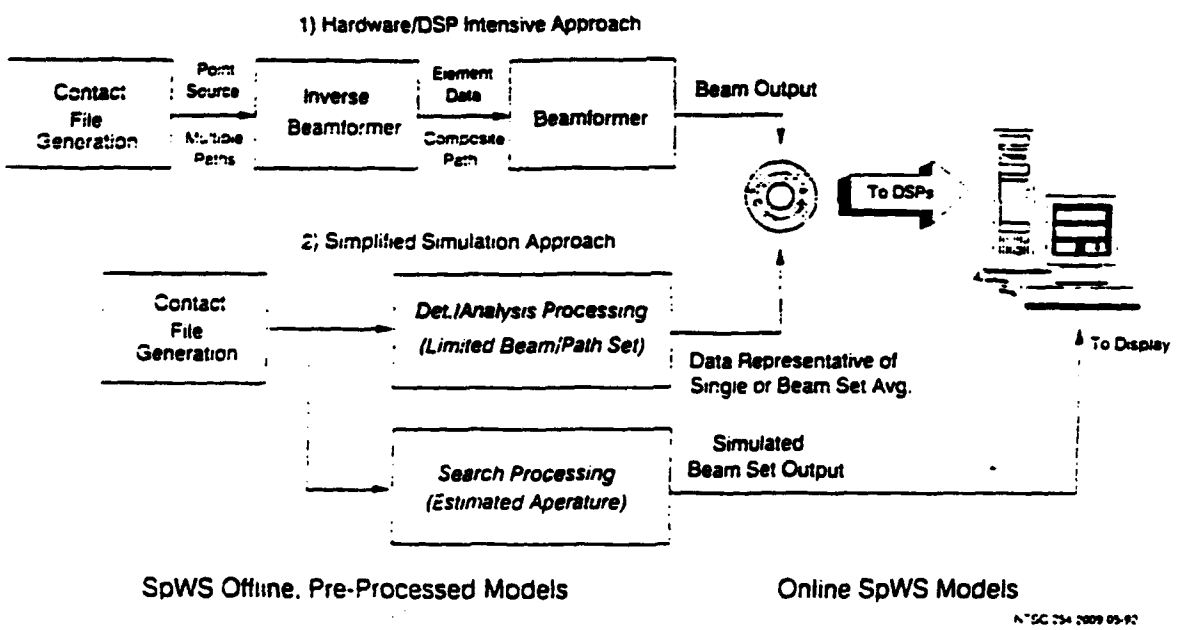
STATUS: This is a new start. In FY93, it is planned to prototype a narrowband signal processing design, develop modeling tools, prototype signal processing (SpWS) displays, and evaluate SpWS capabilities.

MAJOR MILESTONES:

Tactical Processor Analysis	FY93
IVBF/BF Model Development	FY94
Beam Simulation Model Dev	FY95
WS-SIG Proc. Display	FY95
Fidelity Analysis	FY95

ADVANCED SONAR SIMULATION TECHNOLOGY DEVELOPMENT
Exploratory Approach

- *Compare Two Approaches for Fidelity and Benchmarks Using Signal Processing Workstation (SpWS)*



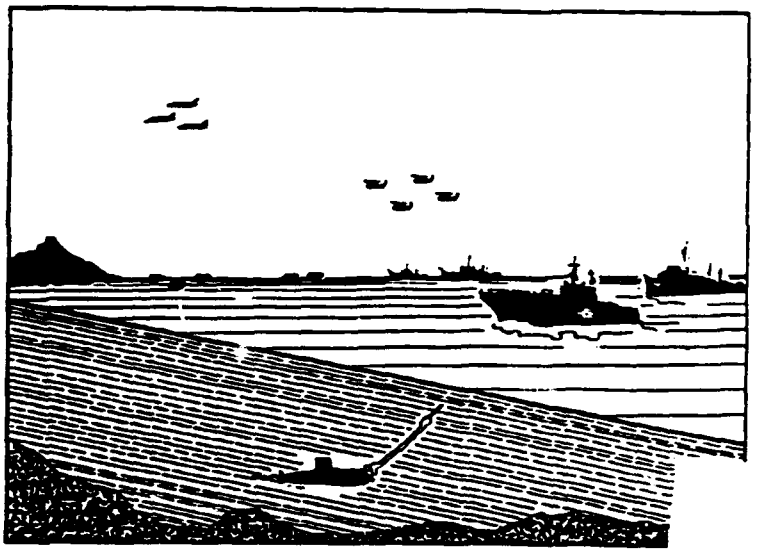
SpWS Offline, Pre-Processed Models

Online SpWS Models

DIS OCEAN MODELS

Principal Investigator - M. McAuliffe
Code 25 Phone: 407/380-4838
DTIC Agency Accession Number: TBD

BACKGROUND: The Navy has an immediate need to develop a Distributive Interactive Simulation (DIS) Protocol Data Unit (PDU) for Ocean Modeling. The critical issue for this effort is ensuring that the Ocean DIS PDU will support a shallow water - range dependent ocean model. There is an additional requirement to provide the instructor display(s) which show multi-sensor and multi-threat ocean effects.



OBJECTIVE: The objectives are to evaluate a draft ocean DIS PDU for adequacy and to develop instructor ocean displays.

BENEFITS: Development of this technology will reduce the risk of errors or omission in the DIS PDU, provide a forum for the evaluation of changes and their associated impact to the DIS PDU, and establish a modular ocean modeling interface and display techniques which may be incorporated into larger complex training systems.

STATUS: This is a new start. In FY93, the Geophysics Fleet Mission Profile Library ocean modeling program will be installed and demonstrated on a personal computer.

MAJOR MILESTONES:

Report preliminary finding on acceptability of draft ocean PDU to DIS Sea Subgroup	FY93
Demonstrate preliminary ocean information displays for instructor guidance and understanding	FY93
Develop DIS PDU for WS#2 and LAN Link	FY95
Develop DIS PDU for WS#3 and LAN Link	FY96

VIRTUAL ENVIRONMENT TRAINING TECHNOLOGY

Principal Investigator - D. Fowlkes
Code 26 Phone: 407/380-4789
DTIC Agency Accession Number: DN702024

BACKGROUND: Virtual Environment (VE) technology is a newly coined term which encompasses a number of display and transducer technologies designed to make human-computer interfaces more efficient and effective. VE technology differs from conventional training simulator technology in that the human computer interface in a simulator is hardware specific to the real world equipment being simulated. Whereas, the interface in a VE system is designed to be specific to the human user's needs for sensory inputs and control outputs with little or no hardware specific to real world equipment. Ultimately, a single VE interface could provide a user with any training environment for any piece of operational equipment. The VE interfaces the trainee user with a training system using displays and transducers. Displays provide information to the user from the training system computer while the transducers relay information from the user to the training system computer. Displays for VE which currently are being developed for VE applications include visual, audio, tactile, and force. Transducers include position, orientation, speech, and force.

OBJECTIVE: This project will analyze and demonstrate the feasibility of using VE technology to improve the efficiency and effectiveness of military training. VE will be evaluated as a training delivery medium; as a replacement for current training media; as an enhancement to current training media; and as an enabling technology capable of providing training in areas where existing training media are inadequate.

BENEFITS: The utilization of VE in military training applications is expected to be an evolutionary process. Existing VE technology is relatively crude and may have limited cost and training effectiveness benefits. Initially, this project will identify the types of training which will benefit from VE technology at its current level of development and provide design guidelines for advanced development for specific training applications. Experience gained from the initial investigations will result in the specification of performance characteristics and features of display and transducer components which will allow application to additional training areas. As these component performance capabilities are developed, additional training areas will be addressed and transitioned.

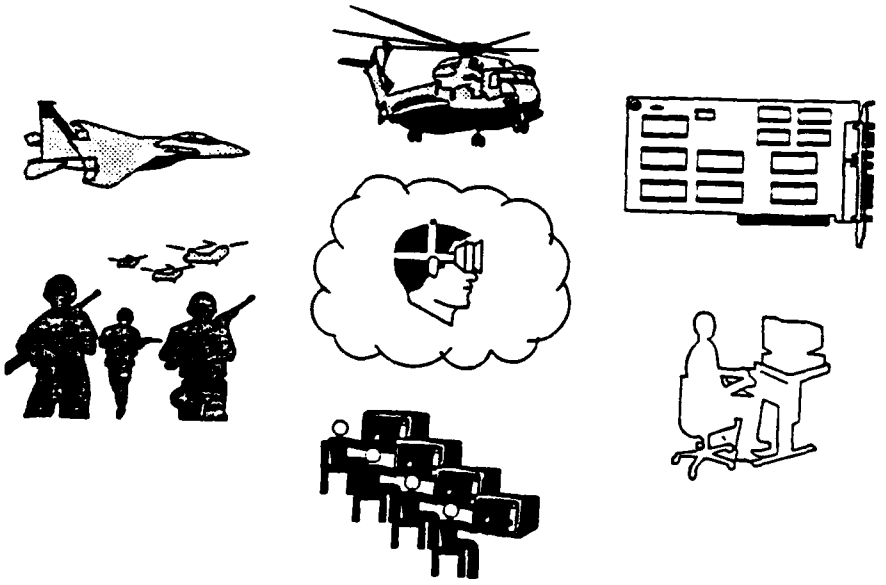
STATUS: An assessment was made of the current state of the art of virtual environment technologies. Several major research issues were identified that must be addressed to provide direction and guidelines for the development of various virtual environment technologies. Significant effort will be directed toward these issues in FY93. The process of "virtualizing" an aircrew debrief station and the comparison of the conventional and virtual configurations of the aircrew debrief station were initiated.

MAJOR MILESTONES:

Demonstration of VE air-to-air combat debrief/replay	FY92
Evaluation of VE air-to-air	FY92

training application	
Demonstration & evaluation of VE control panel operation	FY93
Demonstration & evaluation of VE stick/throttle operation	FY94/FY95
Demonstration & evaluation of VE tutor/instructor	FY96/FY97

VIRTUAL ENVIRONMENT TRAINING



TACTICAL DECISION-MAKING UNDER STRESS

Principal Investigators - E. Salas/J. Cannon-Bowers
Code 26 Phone: 407/380-4651
DTIC Agency Accession Number: DN700019

BACKGROUND: As a result of recent combat events, a fundamental reassessment of requirements for a wide range of Navy systems is taking place. Emphasis is now beginning to shift to the problems of dealing with low- and mid- intensity conflicts where events fit multiple possible hypotheses with respect to contact identification, intent, available responses and their consequences. At present, state-of-the art, real-time battle management systems are based on doctrine that is well-suited to problems that might be encountered in all-out war, but may not be optimum for the problems inherent in less than full-scale warfare. Recent events, such as the one involving the USS Stark, where the decision not to initiate countermeasures was the incorrect one, and the USS Vincennes, where the opposite decision was the incorrect one, have focussed attention on the human factor in decision-making under low- and mid- intensity conflict. The catastrophic costs of these decisions dictate that improved support must be provided to the tactical decision-maker in these unexpected, highly charged, extremely short-duration, confusing situations where it is not clear who the enemy is, let alone what he intends to do.

OBJECTIVE: The objective is to apply recent developments in decision theory, individual and team training, and information display to the problem of enhancing tactical decision quality under conditions of stress. This will be accomplished by a cooperative program in human factors and training involving the Naval Command and Control Ocean Surveillance Center Research and Development (NCCOSC/NRAD) and NAVTRASYSCEN as well as Navy, industrial, and academic organizations. The technology will be demonstrated and evaluated in the context of anti-air scenarios.

BENEFITS: The results of this effort will be an enhanced understanding of human decision-making processes and a set of training and simulation principles that will lead to improved individual and team tactical decision-making under conditions encountered in low-intensity conflict situations.

STATUS: Fleet contacts continue to expand with multiple visits to: Aegis Training Center, Dahlgren, VA; CSEDS (Combat Systems Engineering Development Site and Aegis Training Facility), Moorestown, NJ; Afloat Training Organization and Combat Systems Training Group (formerly Fleet Training Unit and Combat Systems Maintenance Training Team), Mayport, FL, Little Creek, and Norfolk, VA; COMTRALANT; COMNAVSURPA; and several Aegis class cruisers. These visits and interviews have been very productive in identifying tactical tasks and operational scenarios for laboratory investigation. They have resulted in strong operational endorsements of the project and have made important contributions to the development of models of decision-making strategies.

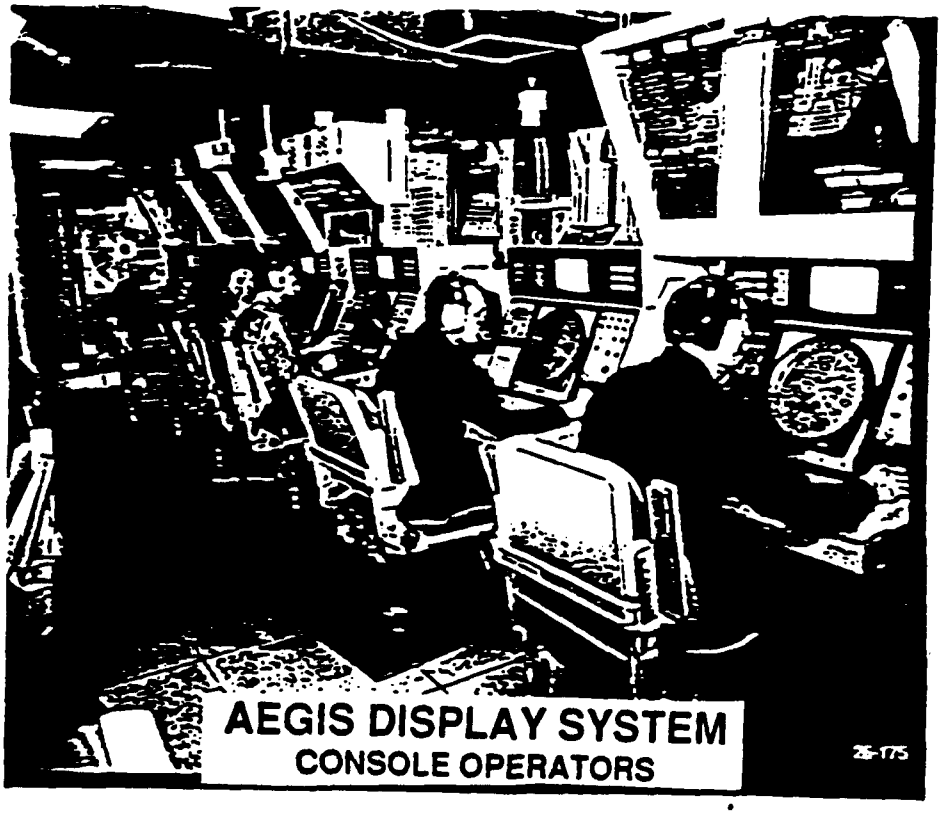
The laboratory simulation testbed, called Decision Making Evaluation Facility for Tactical Teams (DEFTT), has been installed at NAVTRASYSCEN and NCCOSC/NRAD. DEFTT simulates shipboard AAW scenarios and consists of networked workstations for the CO, TAO, AAWC, TIC, IDS, and EWS.

Several performance measures and scales for tactical teams were formulated and refined. These include a Behavioral Observation Booklet which measures individual decision making performance; an AAW Team Observation Measure which measures team process; an AAW Team Performance Index which measures team task outcome effectiveness; a Team Latency Measure which assesses the timeliness with which decision making behaviors are executed. These performance measures were developed with guidance from TACTRAGRUPAC, CSTG, CSEDS, and SWDG.

Progress has been made in defining and selecting task-related and environmental stressors for experimental manipulation. An innovative matrix has been formulated that highlights relationships between training strategies and training content areas.

MAJOR MILESTONES:

Measurement capability to assess tactical decision making by individuals and teams	FY93
Baseline of decision making performance under varying levels of stress	FY93
Tested training principles and recommendations for the development of team instructional strategies	FY94
Tested principles and recommendations for the development of decision support system training	FY94



INDEPENDENT RESEARCH - 6.1
and INDEPENDENT EXPLORATORY DEVELOPMENT - 6.2

Independent Research (IR) and Independent Exploratory Development (IED) programs provide discretionary funds for basic research and exploratory development to the technical directors of Navy laboratories and centers, and the Naval Medical Research and Development Command. The programs provide an opportunity for Navy scientists and engineers to pursue new and innovative research and technology areas for the solution of Navy and Marine Corps problems. This presents several advantages.

Scientists and engineers conduct self-initiated research and exploratory development with emphasis on simulation and training device technologies. This can involve efforts on more speculative approaches that are too risky for funding by existing programs.

Scientists and engineers build in-house expertise in areas of future importance. These skills enhance the "smart-buyer" capability of the Center and provide necessary technical skills to assess development and acceptance of innovative trainers.

The Navy knowledge base and technology base in Simulation and Training Device technology expands. There is no other Navy organization charged with, or capable of, the breadth and depth of the mission of multi-platform, joint service training system research, development, acquisition, and logistical support.

Many ancillary benefits enhance the Navy's strength in Simulation and Training Device technology procurement. Some of them are: the shortening of the time scale of programs; the solving of road block problems which cause delays in programs; a means of rewarding high quality ideas; extending research support for creative scientists and engineers; and providing a stimulating atmosphere conducive to generating new concepts and challenging ideas.

Descriptions of the FY 92 and FY93 IR and IED tasks follow.

DISTRIBUTED DECISION MAKING: IMPLICATIONS FOR TRAINING

Principal Investigator - R. Willis
Code 26 Phone: 407/380-4825
DTIC Agency Accession Number: DN701001

BACKGROUND: Sound decision making is of great practical concern for the military. The reality facing decision makers within today's military is that information, authority, personnel, resources, and expertise are distributed among the members of the military team. The opportunity for coordination and communication prior to making tactical decisions has been diminished, in part, due to the pressure from technological developments. While technology has extended the range over which individuals maintain contact, the quickness with which information can be shared, and the corresponding amount of information created, it has not examined the behavioral impact on the users of these systems. As a result, systems have been designed which push operators to the limits of their ability to make decisions in the face of dynamic, hostile, uncertain environments.

Typically, decisions are made by one member at the top of the hierarchy, while members at the bottom monitor and communicate incoming information. No one member of the military team has sufficient information to perform the decision-making task. This is called distributed decision making--information is not completely shared among those with a role in shaping the decision. The majority of tasks are accomplished by several people providing inputs and products to the functional supervisor who may or may not communicate among themselves and the functional supervisor. This remoteness is anticipated to have an adverse effect on decision making.

The distributed decision-making environment is defined as one in which the team members are physically separated from one another and must communicate via electronic means, a situation one would find during a Battle Force exercise. Effective teams are those that can quickly spin their information web connecting the distant members.

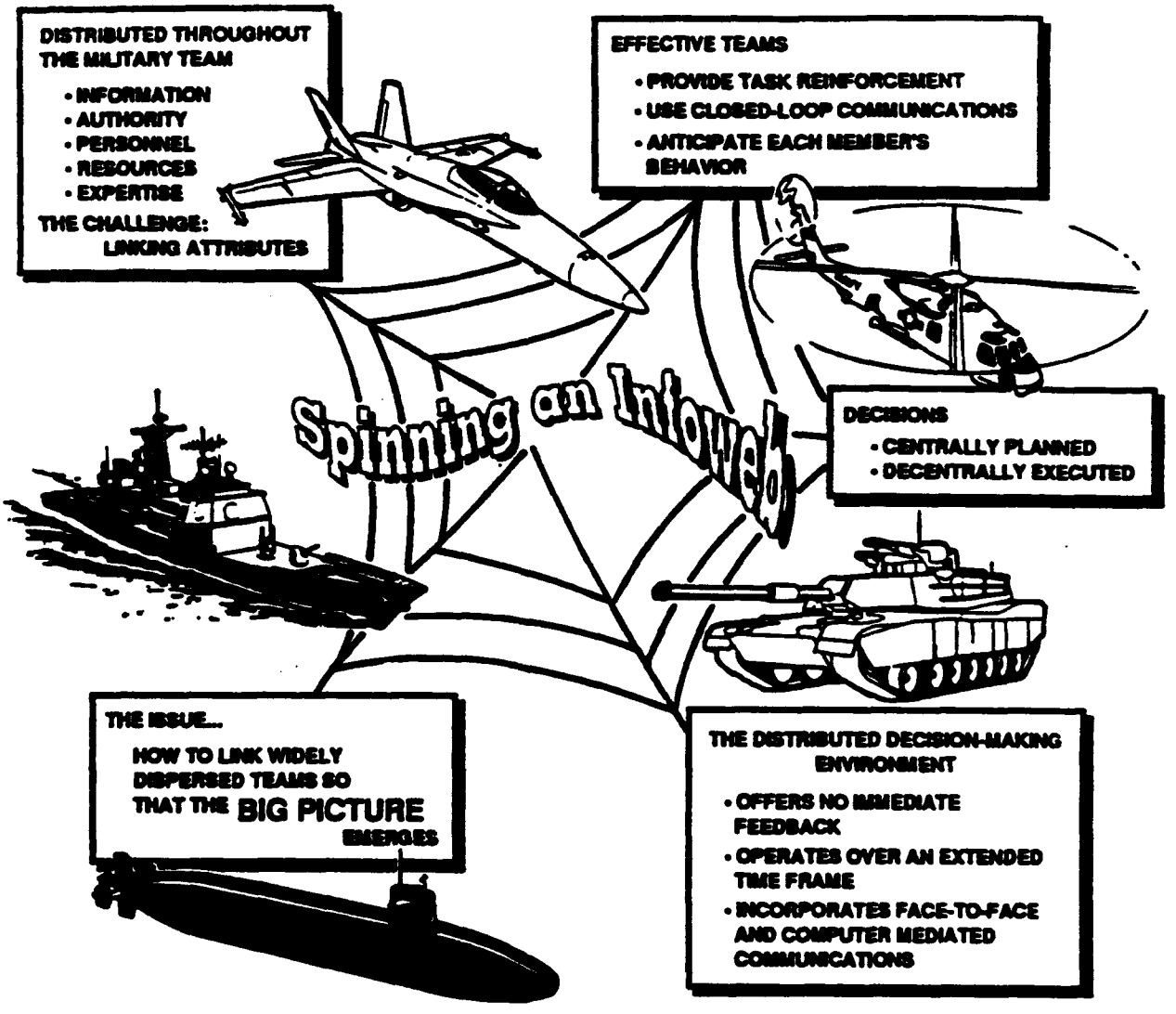
OBJECTIVE: The aim of this research is twofold. First, to investigate factors within the context of distributed decision making that affect the group's decision-making performance. Second, to identify potential training techniques to increase performance in a distributed decision-making environment.

BENEFITS: Successful completion of this research will: 1) delineate factors which lead to effective decision making in a distributed environment; 2) provide recommendations for training techniques to improve distributed decision making; and 3) provide human factors data on information limitations to aid in the design of decision support systems. The outcomes of this study could be used by schools to design training curriculum.

STATUS: The distributed decision-making environment was defined and factors that have the potential to affect distributed decision making were identified. An initial experiment was designed and conducted to study the impact of the physical separation of the team members on communication and decision outcomes using the Team Training Assessment Battery.

MAJOR MILESTONES:

Conduct Decision-Making Experiments Altering Task Environment of Team Members	FY92
Present Research Results	FY92
Publish Research Results and Recommendations	FY93



PHYSIOLOGICAL MEASURES AS A FUNCTION OF FIDELITY OF SIMULATION

Principal Investigator - G. Micheli
Code 26 Phone: 407/380-8282
DTIC Agency Accession Number: DN702022

BACKGROUND: Conflicting results have been obtained from studies concerned with the relationship between fidelity of simulation and training value. In some studies, high fidelity resulted in better training, while in others, lower degrees of fidelity produced equally good, or even superior, training. It is clear from training effectiveness evaluations of training systems that learning retention and transfer occur in situations where "exact simulation" is not present. All transfer effects cannot be related to an analysis of specific stimulus - response relationships.

After many years of research, the contribution that fidelity of simulation makes to the trainee's experience in the simulator has never been answered. To obtain some insight into this phenomenon, we propose the use of the methods of psychophysiological measurement to quantify the effects of different levels of simulation.

Two particular candidate measures include, but are not limited to, the event-related brain potential (ERP), and electroencephalography (EEG). Over the last ten years, the use of the time-locked ERP has shown promise as a measurement technique to characterize and quantify psychological and cognitive processes.

There are reasons for expecting success in this research. Modern data storage and computing techniques can cope with vast quantities of data. Other reasons are such factors as increased signal to noise ratio, new technology that allows telemetry so wires don't dangle from the subject, and computers and amplifiers are now so compact and small.

OBJECTIVE: The objective is to determine whether event-related potentials and other physiological measures change systematically with different levels of fidelity of simulation and whether these physiological measures can be used to assess the role of fidelity in the training environment.

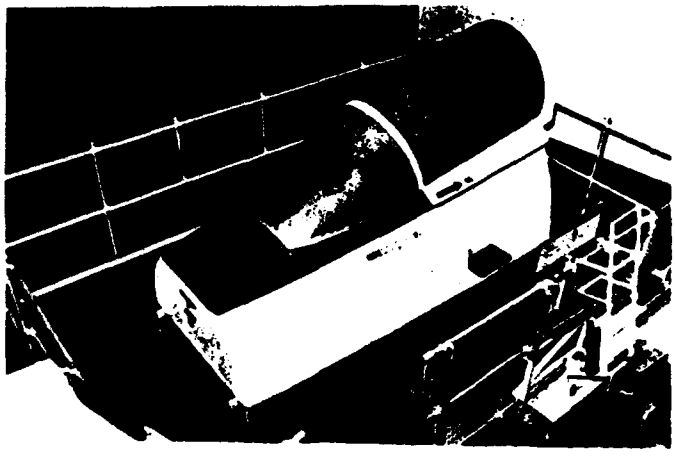
BENEFITS: This effort will attempt to identify the relationship between fidelity of simulation and effectiveness of training in the training environment. The data collected from this research will be the first obtained in an operational training situation. The results from such research would provide a data base to design more definitive efforts to assess the effects of fidelity on training and to estimate the payoffs.

STATUS: A literature review was conducted. An experimental plan was developed. A research collaboration between NAVTRASYSCEN and the Naval Health Research Center has been established. Training systems (F-14A WST and F-14A OFT) that would allow expert pilots to perform the same tasks at different levels of simulation fidelity have been identified. Arrangements for use of the training systems and F-14A pilots have been made with NAS Miramar and COMFITWING, Pacific.

MAJOR MILESTONE

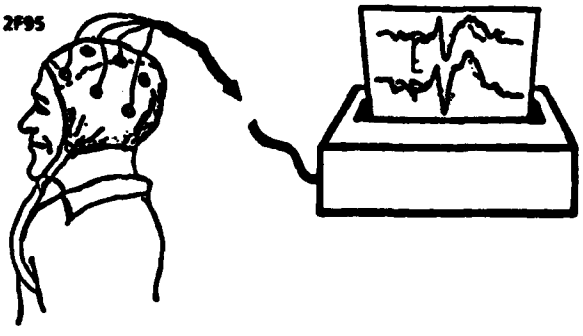
Technical Report FY93

ERP MEASURES AND FIDELITY OF SIMULATION

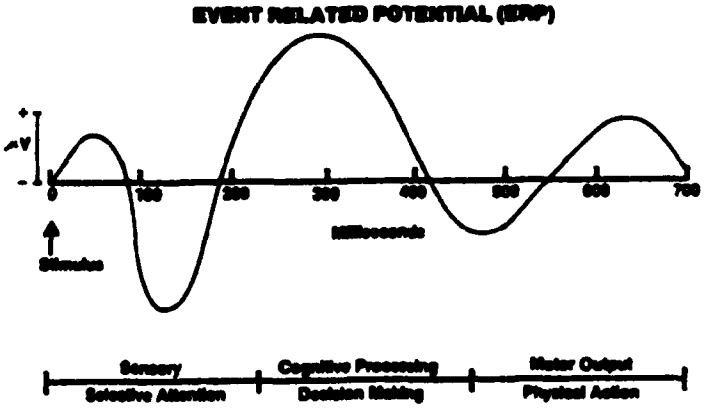


F-14A OPERATIONAL FLIGHT TRAINER, DEVICE 2F95

STIMULI



MEASUREMENT



RESPONSES

ASSESSMENT OF THE TRAINING EFFECTIVENESS OF DUAL DISPLAY COMPUTER BASED TRAINING FOR WEAPONS SYSTEMS WITH GENERIC MAN-MACHINE INTERFACES

Principal Investigator - M. Williams
Code 25 Phone: 407/380-4681
DTIC Agency Accession Number: DN701003

BACKGROUND: Modern submarine and anti-submarine weapons systems are becoming more complex and more computer-reliant. Computer processing capabilities have dramatically increased over the last decade and this has increased the amount of information presented to the weapons system user. In an effort to standardize weapons system equipment, interfaces, and use, many weapons systems (e.g., P3C Update IV) have chosen to use modularized, programmable operator stations. These stations, usually containing a high resolution display and one programmable entry panel, provide the user with a uniform method of interface with the weapons system, regardless of the station's function.

Because the operator can no longer see and access all knobs, switches and indicators directly, but now must use a computer interface to access software "switches" and "indicators," a need has arisen for increased training in the use of the interface between the user and the computerized weapons system (hereafter referred to as the "man-machine interface").

OBJECTIVES: The objectives are to investigate the most effective use of a low cost computer-based trainer to teach fleet personnel in the use of a weapons system with a generic man-machine interface; to evaluate the transfer of training to the weapons system trainer which uses a generic man-machine interface; and to study the most effective tutorial screen designs and training scenarios.

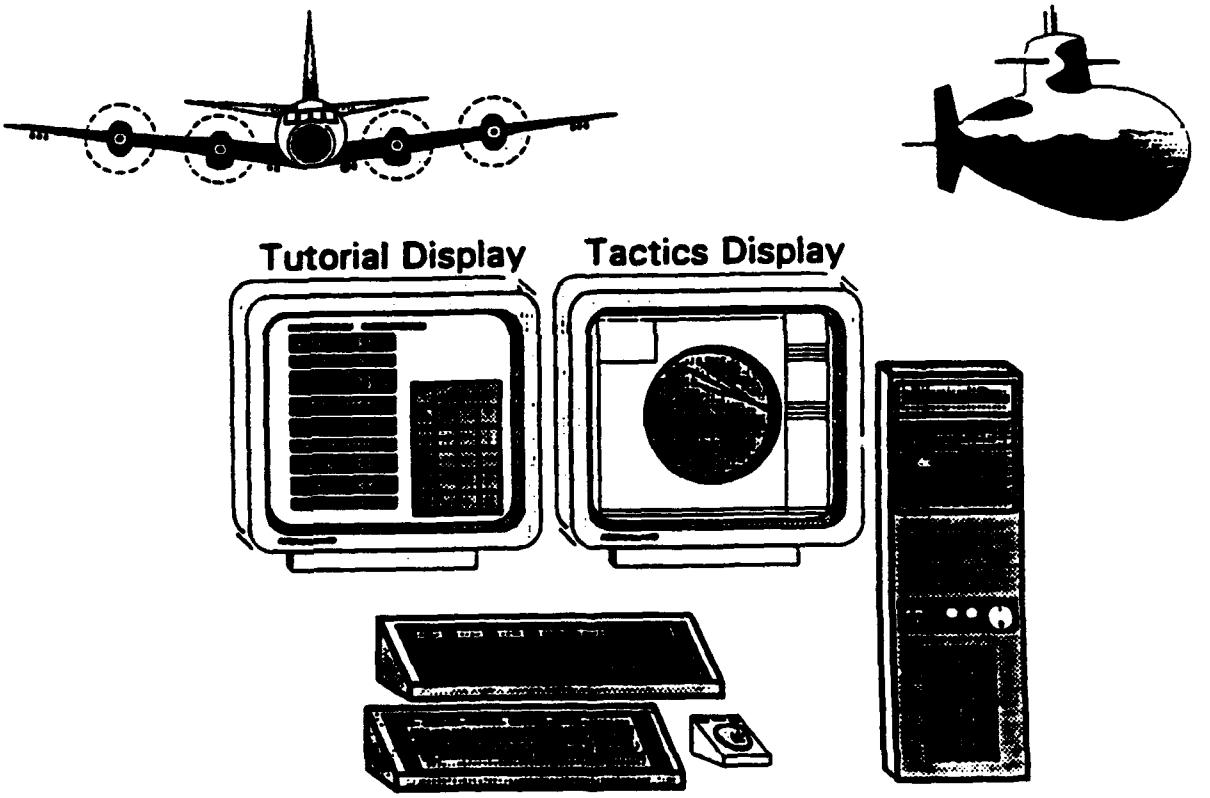
BENEFITS: Successful completion will decrease the time necessary for familiarization training on expensive complex simulators. The availability of complex weapons systems trainers and part-task trainers for weapons system analysis and tactical application training will increase. The new operator will become more proficient in the use of the trainer and utilize the system's full capabilities.

STATUS: A task analysis, centered around the P-3C Update IV weapons system, was performed with the man-machine interface specifications provided by Boeing. These specifications were studied, and with the help of a human factors expert, the information was molded into a tutorial hypertext/graphical database working under the Microsoft Windows graphical user interface. Currently, the software interface for the programmable plasma entry panel is being developed to interface to the tutorial software. Additional software is being written to replicate the tactical screens from the Update IV weapons system.

MAJOR MILESTONES:

Task Analysis Completed	FY91
Hardware Design Completed	FY91
Complete Detailed Software Design	FY92
Hardware/Software Integration Developmental Testing	FY92
Publish Findings	FY92 & FY93

Generic Man-Machine Interface (GMMI)



COMPUTER-AIDED EDITING TOOLS FOR ENGINEERING SPECIFICATIONS

Principal Investigator - J. Oriel
Code 21 Phone: 407/380-4808
DTIC Agency Accession Number: DN701002

BACKGROUND: The DoD spends billions of dollars each year on engineering changes, contract claims, and modifications to recently purchased items. In many cases, these costs could be avoided if weaknesses in the engineering specifications were found and fixed before contract award. NAVTRASYSCEN has developed some software to scan draft engineering specifications to identify some of these weaknesses quickly, thoroughly, and accurately.

Three software programs are presently in use for this application: PARANA, CkList, and SpecTrE. PARANA facilitates the checking of paragraph numbering, cross references, and references to government documents. CkList checks specifications for certain types of error-prone wording and annotates a hard-copy listing with short comments and suggestions. SpecTrE highlights the error-prone words and phrases on the personal computer screen and displays relevant articles from a hypertext knowledge base.

OBJECTIVE: The immediate objective is to continue enhancing an experimental lexicon and natural-language parser that have been added to a CkList-style program, and to develop a semantic processor and a method of representing the knowledge extracted from the text of draft training device specifications. In addition, a new rule set that examines the specifications for errors will be developed.

BENEFITS: Once developed and in use, user-friendly software based on these techniques will reduce cost growth in training systems procurement by helping government engineers produce high quality engineering specifications and statements of work. This technology could be applied to other sectors of government procurement as well. To do so would only require tailoring of the lexicon and rule set. The Civil Engineering Research Foundation has expressed interest in this task for possible application to construction specifications. Representatives of the following organizations have also expressed an interest in this work: the Defense Quality and Standardization Office, the Naval Air Warfare Center Weapons Division China Lake, the Naval Explosive Ordnance Disposal Technical Center, the Naval Ship Systems Engineering Station, the National Institute of Standards and Technology, the Florida Department of Transportation of the State of Florida, and the Federal Aviation Administration.

STATUS: There are two domains of effort to this task. The first is the study of literature that relates to specification writing and the gathering data by examining drafts of NAVTRASYSCEN specifications. The literature comes from a variety of fields: rhetoric, technical writing, legal writing, specification writing, computational linguistics and human communication, to name a few. This "knowledge engineering" part of the task is needed in order to learn more about what affects specification quality.

The other domain is experimentation with software techniques for automating the examination process. So far, this effort has concentrated on analyzing the syntax of

specification sentences. The present version of the parser is an augmented context-free "chart" parser coded in Microsoft QuickBasic 4.5. The parser yields information on sentence structure sufficient to generate reasonably accurate warning messages about certain error-prone types of syntax. In addition, the parser yields information that is used to generate an expanded listing of the entire specification. In the expanded listing, sentences on related topics are clustered together, even though they may have been widely separated in the original document. With the help of such a listing, inconsistent statements are easy to identify, and the task of searching for them may be delegated to a large number of editors.

MAJOR MILESTONES:

Demonstrate Application of Natural Language Parsing to Specification Analysis	FY91
Implement Augmented Parser	FY92
Demonstrate Software with Enhanced Rule Set	FY92
Demonstrate Consistency Checking Capability	FY92
Technical Report	FY93

SEE?...IT DOESN'T REQUIRE THAT YOU ACTUALLY MAKE THE THING WORK UNDER WATER, IT ONLY REQUIRES THAT YOU MAKE IT CAPABLE OF WORKING UNDER WATER!

REAL-TIME ESM SIMULATION SIGNAL GENERATION WITH COTS HARDWARE

Principal Investigator - D. Dyke
Code 21 Phone: 407/380-4113
DTIC Agency Accession Number: DN702023

BACKGROUND: A variety of skills associated with the operation of electronic warfare (EW) and electronic warfare support measures (ESM) equipment requires simulation of the electromagnetic environment. The techniques currently in use are varied. The newest systems utilize general purpose computers for "housekeeping" functions, and special purpose digital hardware for the electromagnetic environment simulation. For example, a recent attempt to satisfy the submarine ESM on-board training requirements was unsuccessful primarily due to the inability of the prototype to provide a sufficiently dense signal environment utilizing real time simulation techniques. Current training requirements can require generation of over 1 million pulses per second, each requiring a 64-bit pulse descriptor word.

OBJECTIVE: The objective of this effort is to develop and demonstrate the simulation techniques required to simulate a dense electromagnetic environment, in real time, utilizing emerging commercial off-the-shelf (COTS) hardware. A secondary objective is to achieve these results with a low cost system with potential for use in portable applications. The effort will focus on real time generation of the pulse descriptor word files which are used in the actual generation of the radio frequency (RF) signals.

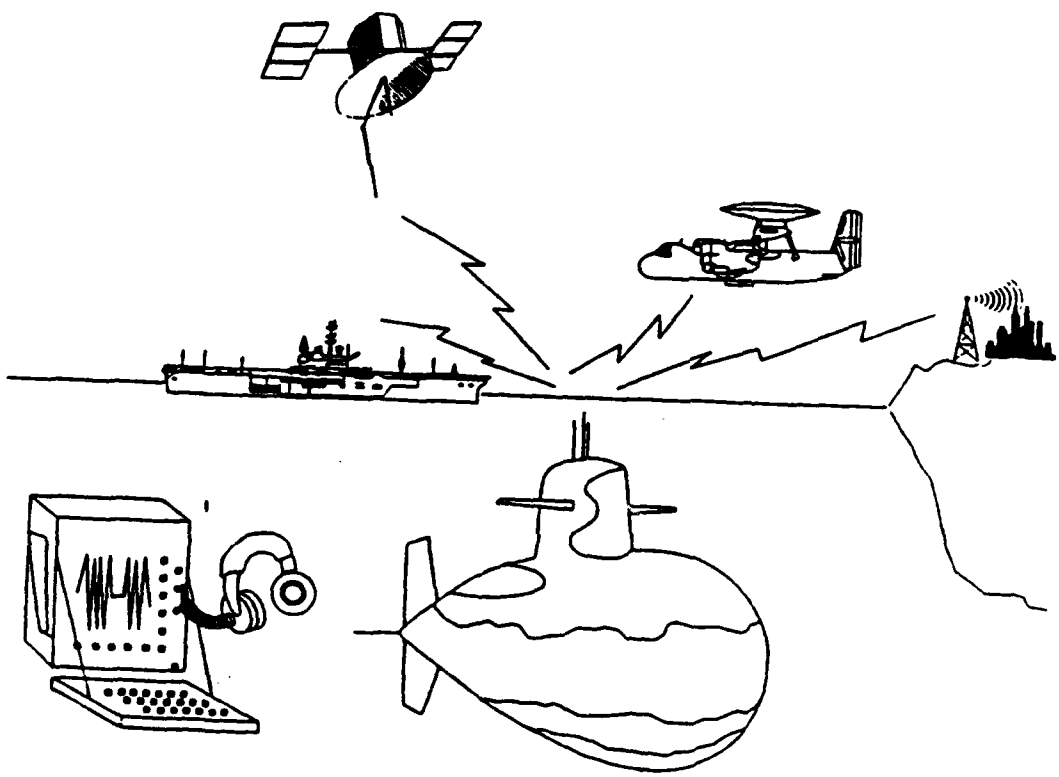
BENEFITS: This effort will further ESM simulation technology in the areas of simulation fidelity, real time performance, and the adaptation of emerging reduced instruction set computer (RISC) technology to simulation problems. The technology will advance the knowledge base of real time simulation techniques and emerging COTS hardware potential in the area of EW simulation. Potential benefits are the possible development of real time capable on-board EW simulators, reduced dependence on special purpose/proprietary hardware, other applications for the reusable software. The result will be better training at lower cost.

STATUS: Several EW stimulation training systems have been reviewed and analyzed in relation to their pulse descriptor word generation. A collection of characteristic software has been baselined and profiled for execution times for several types of radar scan parameters. The pulse descriptor word files have been verified to assure the computational quality of the software.

Continuing efforts will focus on selecting a multi-processing RISC architecture which will allow the software to execute in real-time. Hardware emphasis will be placed on performance, cost, compactness, and portability. The software will be transferred to the new RISC system, with an emphasis on retaining the reusable high-level language implementation.

MAJOR MILESTONES:

Develop EW Baseline Training Objectives	FY92
Develop Software	FY92
Demonstration of Software and Hardware to Generate A Dense Electromagnetic Environment Simulation in Real-Time	FY93



JOINT-SERVICES R&D PROGRAM - 6.4

The objective of this program is to expedite the prototype development of new training technologies and joint-service training data systems that improve training effectiveness and enhance the performance of the military forces. The program was established by the Secretary of Defense to improve training, performance, and readiness of the military departments and reserve components. It also saves DoD funds through the sharing of training and performance information as well as the transfer of emerging and innovative training technologies among the services and private sector. The payoff includes early identification of successful single-service efforts that can be employed on a multi-service/DoD-wide basis for improvement of military operations and training.

WEAPONS TEAM ENGAGEMENT SIMULATION

Principal Investigator - A. Marshall
Code 25 Phone: 407/380-4653

BACKGROUND: This task represents one phase of a broad effort to improve the effectiveness and realism of training a weapon fire team in a simulator environment. Currently, simulator-based team trainers use technology which restricts both realism in tactical training situations and ability for thorough performance measurements. The overall goal of this task is to introduce new technology and techniques which can improve current team training system technology. These new developments include interactive aggressor targets and a high speed weapon tracking system. NAVTRASYSCEN has developed an experimental model which allows nine trainees to engage aggressor targets which are presented on multiple large video projection screens.

OBJECTIVE: The objective of this task is to develop new technology and techniques to improve current team training systems.

BENEFITS: A typical trainee can expend over 5,000 rounds of ammunition during one week of live fire training, which is estimated to cost $905.00. In addition to the savings in ammunition, other benefits are savings in the cost of facilities, ranges, fuel, and transportation to and from the live fire ranges. Safety is also a concern, since the WTET uses no live ammunition, the dangers of an inadvertent weapon discharge or lead poisoning is eliminated.

Continuously tracking weapon aiming points for all members of a fire team expands performance measurement and playback capabilities. Training effectiveness and realism are also increased by instantly removing disabled aggressors from the training scenario, and requiring trainees to take appropriate cover when an aggressor returns fire. This results in an increase in communication and awareness between members of the team. In contrast, previous training systems did not require trainees to seek appropriate cover. Also, aggressor targets were not removed from the progressing training scenario when they were successfully engaged and disabled by trainees. Multiple screens and no cables allow the trainees to maneuver freely.

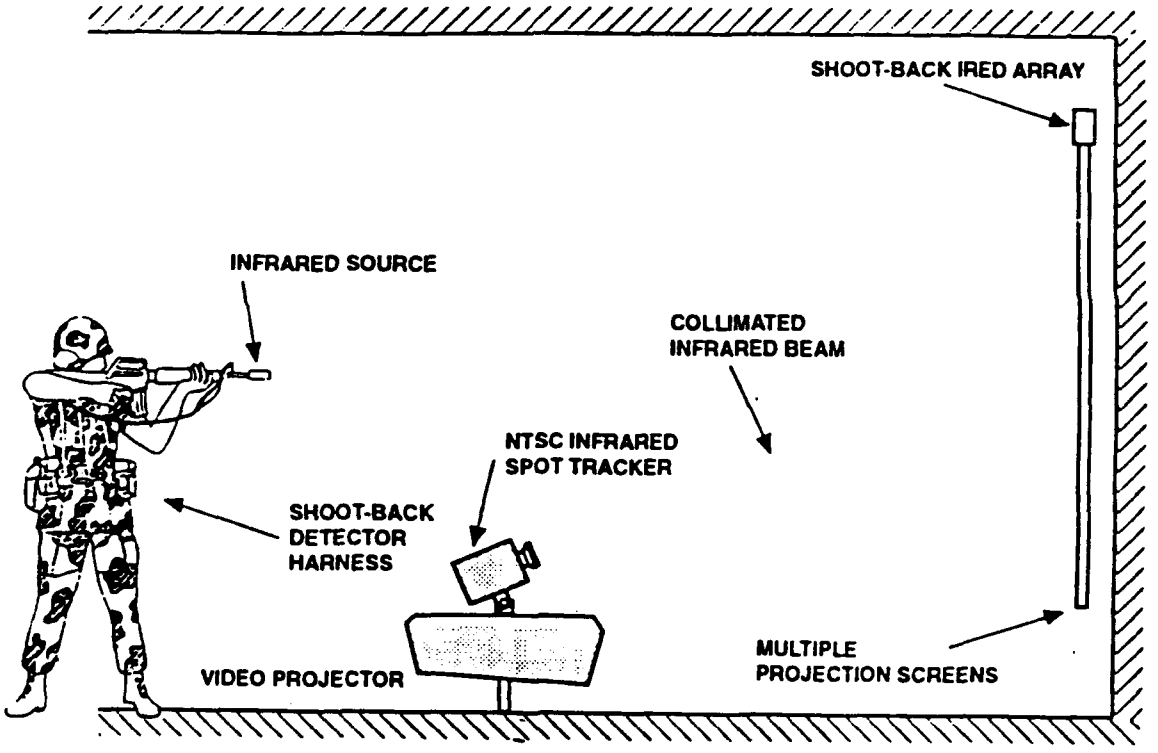
The system will include tracking trainees' movements to both control shoot-back and enhanced feedback, video recording of the trainees, an expert system to control the video scenarios, and an analysis of the results for debriefing using an expert system. The system will also contain no cables to the trainees, allowing free movement inside the trainer.

STATUS: An evaluation model is being developed for close combat training exercises. These exercises include low intensity conflict, light infantry, SWAT, and security operations, with an unsurpassed level of realism and feedback. Typical events might include security operations, hostage rescue, shoot-no-shoot, ambush training situations, and routine law enforcement operations in a common team scenario environment. In the model, aggressor targets are instantly removed from a training scenario as they are disabled by weapon fire from trainees. This increased tactical realism in training by requiring trainees to seek

appropriate cover when engaged by the aggressor targets. An innovative weapon tracking system which generated accurate weapon position data at over 300 Hz was designed and constructed. This device is capable of continuously tracking weapon aiming points for up to 9 trainees. A communications link eliminates the need for cable to the computer system. FY93 will concentrate on training effectiveness evaluations by potential users. Four patent applications have been submitted.

MAJOR MILESTONES:

Design System	FY91
Fabrication	FY92
Training Effectiveness Evaluation	FY93/94



Weapons Team Engagement Trainer Configuration

SMALL BUSINESS INNOVATIVE RESEARCH (SBIR) PROGRAM - 6.5

The Department of Defense (DoD) SBIR program was developed to stimulate technological innovation in the private sector, strengthen the role of small business in meeting DoD R&D needs, foster and encourage participation by minority and disadvantaged persons in technological innovation, and increase commercial application of DoD supported R&D results. Small business firms with strong R&D capabilities in science and engineering are encouraged to participate in the program. Subject to availability of funds, the program supports R&D proposals for innovative concepts related to important defense-related scientific or engineering problems.

The SBIR program is a 3-phase program:

Phase I is to determine the scientific or technical merit and feasibility of ideas. This will typically be one-half person-year effort over a period not to exceed six months. Successful completion is a prerequisite for funding in Phase II.

Phase II awards are made on the basis of results from Phase I and on the scientific and technical merit of the Phase II proposal. This phase is the principal research or R&D effort. Proposers are asked to consider whether the R&D they are proposing also has commercial possibilities. If so, proposers are encouraged to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funding phases. Phase II typically covers 2 to 5 person-years of effort over a period generally not to exceed 24 months. Phase II is expected to produce a well defined deliverable product or process, and a more comprehensive proposal is required.

Under Phase III, non-federal capital is expected to be used by the small business to pursue commercial applications of the R&D. This phase is designed, in part, to provide incentives for converting federally-sponsored R&D innovation in the private sector.

To request copies of the SBIR solicitation, contact the Defense Technical Information Center, Attn: DTIC/SBIR, Bldg 5, Cameron Station, Alexandria, VA 22304-6415; telephone 1-800-368-5211 (Virginia, Alaska and Hawaii call 202/274-6902.) The solicitation provides information on how to submit proposals.

KNOWLEDGE-BASED INTELLIGENT TUTORING SYSTEM (ITS) DEVELOPMENT TOOL FOR TABLETOP TRAINING SYSTEMS

Principal Investigator - T. Kopke
Code 25 Phone: 407/380-4589

BACKGROUND: Intelligent Tutoring Systems (ITSs) typically take a significant amount of time and resources to develop. Some of the components, such as those that manage the training session and student performance, could be predefined so that ITS development would take less effort. The tool itself should be based on expert system technology, both for control over the development environment and for final ITS execution. Given such an ITS development tool on a low-cost, tabletop computer system, the course writer need only concentrate efforts on the specifics of the information to be learned by the student.

OBJECTIVE: To design and develop a low-cost, intelligent, tabletop trainer development system. The system would enable rapid prototyping of ITSs.

BENEFITS: Development of tabletop trainers would require significantly fewer resources, enabling greater deployment of the technology.

STATUS: An SBIR contract is in the process of being awarded.

GAS MASK SENSOR TO DETECT
WHETHER MASK IS FULLY SEALED

Principal Investigator - R. Carson
Code 26 Phone: 407/380-4829
DTIC Agency Accession Number: TBD

BACKGROUND: The ability of personnel to don the gas mask quickly and effectively is basic to survival in a chemical environment. Although the protective mask is the single most crucial article of chemical defense equipment, there is no current training-effective shipboard method for mask donning drill. Mask training currently takes place during Recruit Training. The training consists of entering a tear gas chamber while wearing the sealed mask, breathing through the filter a few times, and then removing the mask so that the contrast with the protected state is appreciated. This method of training is not feasible for a shipboard environment. Also, research has indicated that the tear gas chamber exercise sometimes decreases confidence rather than promoting it. This occurs because many students are unable to seal their masks, but they do not report their failure for fear of having to repeat the exercise.

OBJECTIVE: To identify the best system for measuring gas mask leaks. The device is to be used in training exercises to enhance performance of the mask donning task and provide objective feedback.

BENEFITS: Use of a sensor to indicate whether or not the mask is fully sealed would provide objective feedback to the mask wearer as well as to the instructor. The immediate and objective feedback provided will greatly enhance the mask donning practice.

STATUS: An SBIR contract is in the process of being awarded.

MAJOR MILESTONES:

Comprehensive review of technologies	FY93
Trade-off analysis to select most cost-effective method	FY93

MCU-2/P Mask with Audiopack B-181

LOW COST COMPUTER IMAGE GENERATOR FOR NIGHT VISION

Principal Investigator - T. Kopke
Code 25 Phone: 407/380-4589
DTIC Agency Accession Number: TBD

BACKGROUND: Efforts are currently underway to develop low cost display systems to simulate night vision goggles for use in flight training simulators. A low cost image generator is needed to drive these displays. The computer image generator is different than the usual CIG found in simulation because the NVG display is monochrome. The low cost generator should be capable of displaying night vision terrain for use in flight simulation. The data base created for the low cost CIG will coordinate with an existing daylight data base. Provisions for inputs of flight parameters, data base location, and attitude are required. Since NVG viewing window can change dependent on the simulated flight, a provision for input of head attitude information will be provided.

OBJECTIVE: The objective of this effort is to design and construct a prototype low cost computer image generator.

BENEFITS: The final product will have operating features and performance comparable to image generators that cost $200K-$300K currently being used for visual simulation. The target cost will be approximately $100K for a system that will have photo texturing and true perspective. The lower cost and modular design will allow easy modification to adapt to a variety of low cost simulation approaches while maintaining scene fidelity that is required for many tasks such as NVG training.

STATUS: A Phase II effort is currently underway with a design that incorporates a hyper-cube type technology.

LOW COST NIGHT VISION GOGGLES FOR SIMULATION

Principal Investigator - T. Kopke
Code 25 Phone: 407/380-4589
DTIC Agency Accession Number: DN702037

BACKGROUND: The increased use in night vision goggles (NVG) for flight has prompted the need for night vision flight training. Night vision systems used in flight have a limited field of view and do not allow for use of periphery cues when flying nap of the earth. A low cost display system that mimics operational NVG hardware for simulation training is needed. The low cost simulated monochrome NVG display will have display rates compatible with current flight simulation computer image generators and will be comparable in weight if worn on the head. Optical and physical parameters will be, or similar to, that of operational NVGs.

OBJECTIVE: The objective of this effort is to design and construct two prototypes based on two different display technologies: liquid crystal display (LCD) and cathode ray tube (CRT). The final delivered products will simulate the ANVIS NVG system that would accept standard video from either computer image generation or video disk based image generation systems.

BENEFITS: The final NVG system would allow NVG training in any dome simulator and would not be restricted by display type inside the dome. Because of the emphasis on low cost, NVG training could then be performed in a low cost simulation environment, such as part task or a classroom, allowing additional NVG training opportunity.

STATUS: Phase II efforts are currently underway to construct a CRT and a LCD based system that will operate with standard video inputs.

ANCILLARY FUNDED TASKS

During the normal cycle of program reviews, some Navy R&D sponsored efforts are found by others to contain elements which apply to their own requirements. When this happens, NAVTRASYSCEN examines the similarities and differences in requirements and applications. A determination is made as to whether there is a significant issue and, if so, who is best able to pursue the technology.

Likewise, the Navy trainer community's review of emerging R&D identifies applications which were not considered during technology development. A determination is made as to whether a modification to the on-going effort would allow expansion to these additional applications or to establish a special task.

The tasks in the following section were determined to be pursued best by NAVTRASYSCEN due to special talents, capabilities, or facilities. They may be funded by other Navy activities, other services, or DoD agencies.

ELECTRONIC WARFARE CONTINUUM ASSESSMENT PROGRAM

Principal Investigator - M. Bergondy
Code 26 Phone: 407/380-4777

BACKGROUND: The need to document warfighting readiness and training effectiveness is a major concern for warfare sponsors, operational commands, and training system developers. The Electronic Warfare Continuum Assessment Program (EWCAP) examines EW performance and training effectiveness across the careers of Naval Aviation personnel. Platform specific EW tests are designed and developed through collaboration between fleet subject matter experts and NAVTRASYSCEN personnel. Using a computer based program, the EWCAP tests are administered to all aircrew personnel. The data are reduced and analyzed by NAVTRASYSCEN personnel, identifying strengths and weaknesses within each community and highlighting necessary remedial and training enhancing actions or policies.

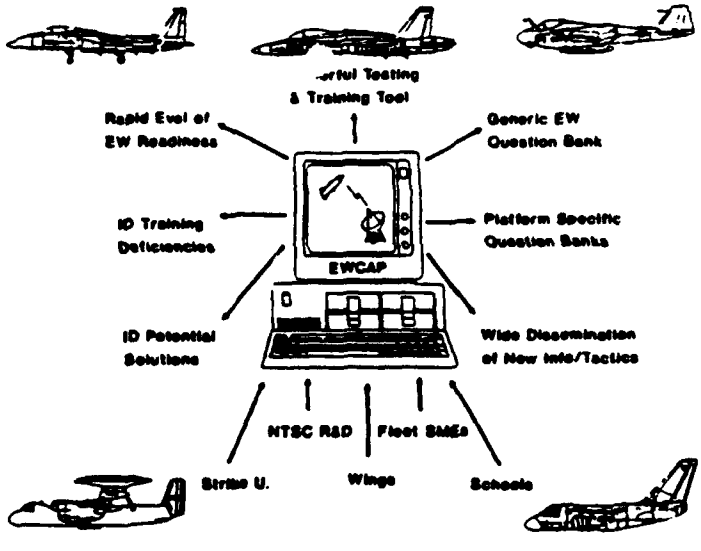
OBJECTIVE: The objectives of the EWCAP are to develop a method for rapid evaluation of EW readiness in Naval Aviation communities, provide to the Chief of Naval Operations and the Naval Air Systems Command documentation of EW performance and training deficiencies, and make recommendations for solutions to identified training problems.

BENEFITS: Each evaluation identifies specific EW strengths and weaknesses within a community. Repeated testing determines whether changes implemented in the training cycle have significantly impacted operational performance. Finally, while the primary goal of the EWCAP is to evaluate skills and knowledge, each test is carefully constructed to offer maximal training benefits through the use of extensive instructional feedback. This feedback provides a vehicle for rapid dissemination and reinforcement of new and revised threat and tactical information.

STATUS: The initial assessments of the EA-6B, F/A-18, A-7, and E-2C communities are completed. The S-3 test results are currently being analyzed. The A-6 evaluation is continuing for a second year. Completion of the initial evaluations of the F-14 and EP-3 and the retesting of the EA-6B, F/A-18, and E-2C are planned for FY93.

MAJOR MILESTONES:

Reevaluate EA-6B	FY92
Complete S-3 Analysis	FY93
Complete Initial Assessments of F-14 and EP-3	FY93
Reevaluate EA-6B	FY92
Reevaluate all Platforms	FY93



PRODUCTIVITY ENHANCING CAPITAL INVESTMENTS
REUSABLE SOFTWARE

Principal Investigator: L. Keeler
Code 25 Phone: 407/380-4627

BACKGROUND: The demand for new software is increasing faster than current approaches to software development are able to supply it. Software development is labor-intensive, and software systems in general are more complex than ever before. The increased complexity of the weapons platforms and weapons systems for which training systems must be designed and built serves to further the requirement for even more complex software.

OBJECTIVE: This task will provide the hardware and software necessary for a Reusable Ada Software Component Repository for Training Systems for the NAVTRASYSCEN. It will include rules and guidelines for use in developing reusable Ada software source code components together with automated tools to assess the adherence of newly developed software to these rules. It will also include an extensible set of reusable Ada software source components to populate a repository, and the requisite hardware and tools for storage, retrieval and configuration management of the components in the repository.

BENEFITS: It has been proposed that a collection of reusable software components could reduce the cost of software development, improve the quality of products, and accelerate software production. Productivity in the range of 20,000 lines of code per man-year as opposed to the average of 2,000 lines of code have been attributed to extensive use of reusable code. More conservative studies indicate that 40 - 60% of the software code written is repeated in multiple applications. If only the most conservative estimates are true, significant savings are realizable if a program for identifying, storing and providing for easy locating and accessing of these reusable software components is made available.

Making reusable software components available to contractors will permit them to bid more competitively while simultaneously improving the software reliability and maintainability. The rules and guidelines and the automated reusability assessment tools will assist both contractor and in-house software developers in developing high quality reusable Ada software components. In addition, these tools will assist software acquisition activities in ensuring that the software acquired in Navy trainer acquisitions meets the quality standards required for reusability. The reusable software repository hardware and its configuration management tools will maintain the reusable software components in an on-line system, while the automated library retrieval system tools will ensure that they may be easily identified and accessed for reuse in future software applications.

STATUS: A contract was awarded to provide a Reusable Ada Software Component Repository, including: an objective set of rules and guidelines for reusable Ada components specifically tailored to the training simulator domain; the requisite tools for storage, retrieval and configuration management of reusable flight simulator components; example reusable flight simulator components for seeding and demonstrating the repository; and a set of reusability assessment tools for ascertaining the degree to which Ada software components

submitted for inclusion in the repository adhere to the established objective set of rules and guidelines for reusability in the training simulator domain.

MAJOR MILESTONES:

Hardware to host an extensible repository of reusable Ada source code software components	FY92
Automated set of tools for cataloguing and accessing Ada source code components ccontained in the repository	FY92
A set of rules and guidelines for use by software developers in creating reusable Ada source code software components which will ensure that these components possess the attributes, features and characteristics which contribute to reusability	FY92
A demonstration set of reusable Ada source code software components possessing the attributes, features and characteristics which contribute to reusability to demonstrate the feasibility of a reusable Ada source code archival library	FY92
An automated set of tools for assessing the degree to which Ada source code software components possess the attributes, features and characteristics which contribute to reusability	FY93

SIMULATOR SICKNESS ASSESSMEMT PROGRAM

Principal Investigator - S. Jones
Code 26 Phone 407/380-4152

BACKGROUND: Enhanced simulator fidelity has resulted in improved training effectiveness, as well as increased pilot acceptance. However, as the sophistication of simulation has increased, so have reports of simulator induced sickness. To the extent that simulation technology violates principles of human factors engineering, the incidence of simulator sickness may continue to rise.

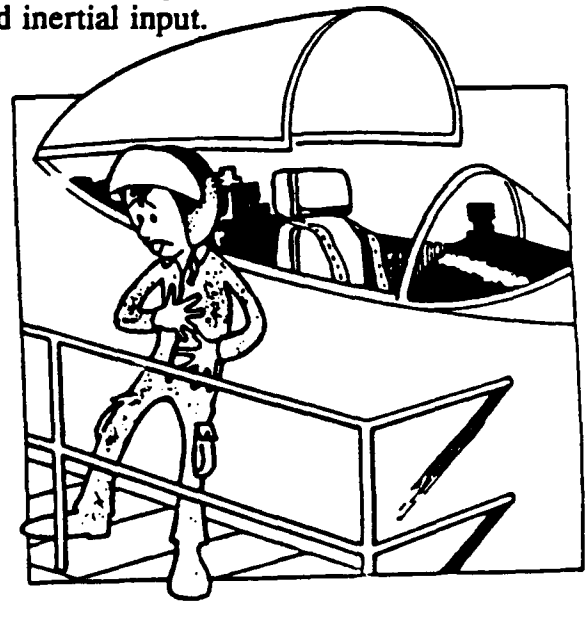
OBJECTIVE: Until improvements in engineering design reduce or alleviate the incidence of sickness in training devices there is a need to: (1) document incidence rates to identify which systems induce unacceptably high levels of sickness; (2) determine the extent to which symptomatology is a function of specific simulator engineering configurations as well as visual and inertial stimulus input; (3) generate design criteria to be incorporated into trainer specifications, standard acceptance tests and operational test and evaluation procedures.

BENEFITS: A reduction in the incidence of simulator sickness for any given trainer will: a) reduce safety and health risks (including locomotor ataxia, interference with higher-order manual control, physiological discomfort, and visual aftereffects or flashbacks); b) increase operational readiness through relaxation of mandatory grounding policies; c) enhance training effectiveness and pilot acceptance; and d) exercise the use of engineering capabilities to their fullest extent.

STATUS: NAVTRASYSCEN is currently examining the relationship between simulator platform motion (on vs. off) and display type (CRT vs. wide-angle visual display) and the incidence of simulator sickness experienced in five rotary and fixed-wing trainers. Analyses of the data indicate that the greatest incidence of simulator sickness occurs in rotary-wing trainers with motion bases and CRT displays. An engineering test plan has been developed for the purpose of measuring characteristics of the simulator visual display, image generator, and motion hardware suspected to play a causal role in the onset of symptoms. In order to produce generalizable results, an effort is planned to develop continuous on-line measures of the kinematic characteristics of the visual and inertial input.

MAJOR MILESTONES:

Examine Contributions of Motion Display	FY92
Develop Measures of Visual Display Kinematics	FY93
Examine Contributions of Visual Display Kinematics	FY93
Technical Report	FY94



DEVELOPMENT OF COST AND TRAINING EFFECTIVENESS STANDARDS

Principal Investigator - G. Micheli
Code 26 Phone: 407/380-8282
DTIC Agency Accession Number: TBD

BACKGROUND: DoD is interested in expanding capabilities related to analyzing training requirements of new training interventions designed for team and individual training systems. There is a need to define cost and training effectiveness of training systems in order to support many of the upcoming applications of simulated distributed environments for both service interoperability and joint training.

The Office of the Assistant Secretary of Defense for Force Management and Personnel (OASD/FM&P) has a requirement to monitor the effectiveness of military training within the DoD to ensure that military training is allocated sufficient resources to maintain combat readiness. As part of this requirement, decision makers for training system design need executive level information on simulators/simulations and their effectiveness, particularly with regard to team training in order to properly articulate the role of training systems.

Specifically, the principal goal of this project is to support FM&P readiness and training with the development of a DoD standard for evaluating the cost and training effectiveness of training systems. This will require a comprehensive assessment of the scope and efficacy of cost and training effectiveness analysis methodologies and an identification of methods, data requirements, and common variables relating to assessing DoD training systems. The lack of a DoD standard for cost/training effectiveness evaluation makes it difficult to ensure that training systems are meeting training requirements at an affordable cost. The lack of consistent and reliable cost and training effectiveness data makes it difficult to link training and readiness and to justify training system funding requirements.

OBJECTIVE: The objective is to develop DoD standards for evaluating the cost and training effectiveness of team training systems.

BENEFITS: The development of a DoD standard for evaluating the cost and training effectiveness of training systems will provide a tool for government decision makers to make proper choices about optimal training system design and cost. It will also assist in quantifying the effectiveness of DoD training systems in terms of operational/combat performance and impacts on readiness.

STATUS: Current methodologies for cost and training effectiveness evaluations are being assessed. Potential variables, methods, and needs for a DoD standard are being identified. A standard for cost and training effectiveness evaluation of team training systems is being developed.

MAJOR MILESTONES:

Report on potential cost and training effectiveness variables, methods and data needs	FY93
Report on recommendations for use of cost and training effectiveness methodologies	FY93
DoD standard for evaluating the cost and training effectiveness of team training systems	FY93
Technical report to document efforts, findings, recommendations, and products from the study	FY94

TECHNOLOGY TRANSFER

Point of Contact - J. Weisenford
Code 2B Phone: 407/380-8276

The Federal Technology Transfer Act of 1986 requires federal agencies to optimize the investment of tax dollars in R&D by sharing knowledge and products with other organizations, both public and private. The Act provides for joint research projects between federal laboratories and others as well as commercialization of laboratory products. It also encourages federal laboratories to provide technical volunteers to the community in which they are located.

Through technology transfer, Congress believes that there will be significant benefits to the public. Congress noted that many government patents were not licensed and, therefore, government inventions were not commercialized. To encourage licensing of government patents, Congress built incentives into the Federal Technology Transfer Act. Government inventors and the laboratories where they work share part of the royalties generated from the commercial use of their inventions. The inventor and the labs profit through this commercialization and our economy is enhanced through manufacturing and sale of new products.

There are benefits to the public from the exchange of knowledge and products within the government. Exchange includes sharing information and products with other federal agencies, as well as with state and local governments. By sharing knowledge and products on a wide basis, the public reaps the benefits from research conducted for one purpose or agency in many new ways. The return on the investment of the tax dollar is increased.

Another benefit from the Federal Technology Transfer Legislation is the establishment of the Federal Laboratories Consortium. (FLC). This consortium is a network of over 500 federal labs. The FLC is a clearinghouse for technology transfer and a source for helping agencies learn how to transfer technology. NAVTRASYSCEN is a member of the FLC.

NAVTRASYSCEN has a long history of technology transfer to both the public and private sectors. For example, the overhead projector was developed under a NAVTRASYSCEN contract in 1944 to project plot charts for navigation training. The overhead projector is used in nearly every classroom.

Today, the Center is actively pursuing technology transfer through a number of initiatives. Some of the key initiatives are described below.

COOPERATIVE R&D AGREEMENTS (CRADA's)

NAVTRASYSCEN currently has five CRADA's:

o PARAGON GRAPHICS - Paragon Graphics and NAVTRASYSCEN will develop, integrate, demonstrate, and evaluate Helmet Mounted Display technology. There have been two demonstrations of the research efforts, with additional demonstrations scheduled.

o EMBRY RIDDLE AERONAUTICAL UNIVERSITY - Embry Riddle Aeronautical University and NAVTRASYSCEN will evaluate a Radio Instruments Orientation Trainer (RIOT). NAVTRASYSCEN will place RIOT at Embry Riddle Aeronautical University, and Embry Riddle Aeronautical University will use RIOT as part of their instruction. NAVTRASYSCEN will benefit from the formal evaluation of RIOT, with the potential for civilian commercial application. The University will benefit from the application of RIOT and from this research opportunity.

o UNIVERSITY OF CENTRAL FLORIDA/INSTITUTE FOR SIMULATION AND TRAINING - Through this CRADA, NAVTRASYSCEN and UCF/IST will apply Computer Assisted Software Engineering (CASE) tools to evaluate simulation software. NAVTRASYSCEN has expertise in the use of CASE tools for simulation software evaluation. UCF/IST will provide computer software experts to learn how to use the CASE tools and to conduct software evaluations as part of their training. IST will procure additional CASE tools to use in the evaluations and will assess a structural model developed by the Software Engineering Institute. This agreement will benefit the Navy by providing NAVTRASYSCEN with trained individuals to conduct software evaluations and by providing access to additional CASE tools for software evaluations. UCF/IST will benefit by increasing their level of expertise in this area.

o LORAL DEFENSE SYSTEMS-AKRON - NAVTRASYSCEN and Loral Defense Systems-Akron will perform R&D on the development and evaluation of a prototype cockpit training system applying Helmet Mounted Display (HMD) technology. NAVTRASYSCEN has conducted R&D in HMD and has several patents. Loral is experienced in the development of low-cost cockpit training systems and high speed, high capability advanced cockpit training simulators. The CRADA will involve the development, integration, and testing of the combination of simulation software and databases, simulation crew station hardware, and simulation Helmet Integrated Display (HID) hardware, to evaluate the viability of the HID application in simulator devices.

o DYNAMICS RESEARCH CORPORATION - NAVTRASYSCEN and Dynamics Research Corporation (DRC) will perform R&D on computerized gaming systems for military training, and will explore the resulting game shell's commercial viability. NAVTRASYSCEN will provide its personnel and expertise in the development of training games for the Navy, and DRC will provide its extensive experience in R&D and marketing of training software. They will define the requirements for, design, and develop a game shell from which games can be developed, and a prototype game that will be used to demonstrate the game shell. The game shell will be completed by January 1992. DoD use of the game shell includes aviation training and armor training.

SCHOOL YEAR 2000

School Year 2000 is an initiative of the Florida Department of Education and the Center for Educational Technology at Florida State University to design and implement new models of schooling. NAVTRASYSCEN is assisting with this project as a member of the Policy Advisory Board. The Center signed a memorandum of understanding with the

Florida Department of Education. NAVTRASYSCEN received recognition for its support of School Year 2000 in a letter to the CNO from Florida's governor Lawton Chiles.

MEMORANDUM OF UNDERSTANDING (MOU)

Current MOU's involving technology transfer include:

o NASA, KENNEDY SPACE CENTER (KSC) - The Navy is sharing correspondence and computer base training materials and is assisting with computer based training system design and evaluation. NASA, KSC is providing access to subjects in support of Navy research on external factors influencing training effectiveness and access to technical experts in the areas of ADA, networking and telecommunication. NASA is also allowing NAVTRASYSCEN to participate in NASA funded training for Interactive Courseware development.

o FEDERAL AVIATION ADMINISTRATION (FAA) - NAVTRASYSCEN will provide advisory and consulting services in simulation and training. FAA will provide consulting and advisory services in a variety of areas including multimedia implementations and Computer Based Instruction.

LOCAL TECHNOLOGY TRANSFER

o MAITLAND MIDDLE SCHOOL - NAVTRASYSCEN is a member of Maitland Middle School's Educational Technology Committee. The school is expanding its use of computers as tools for teaching. The Center demonstrated some of the Navy's applications of technology for instruction at Maitland Middle School. The school's faculty are evaluating the Serious Pursuit Shell and are providing feedback on its use in middle school education.

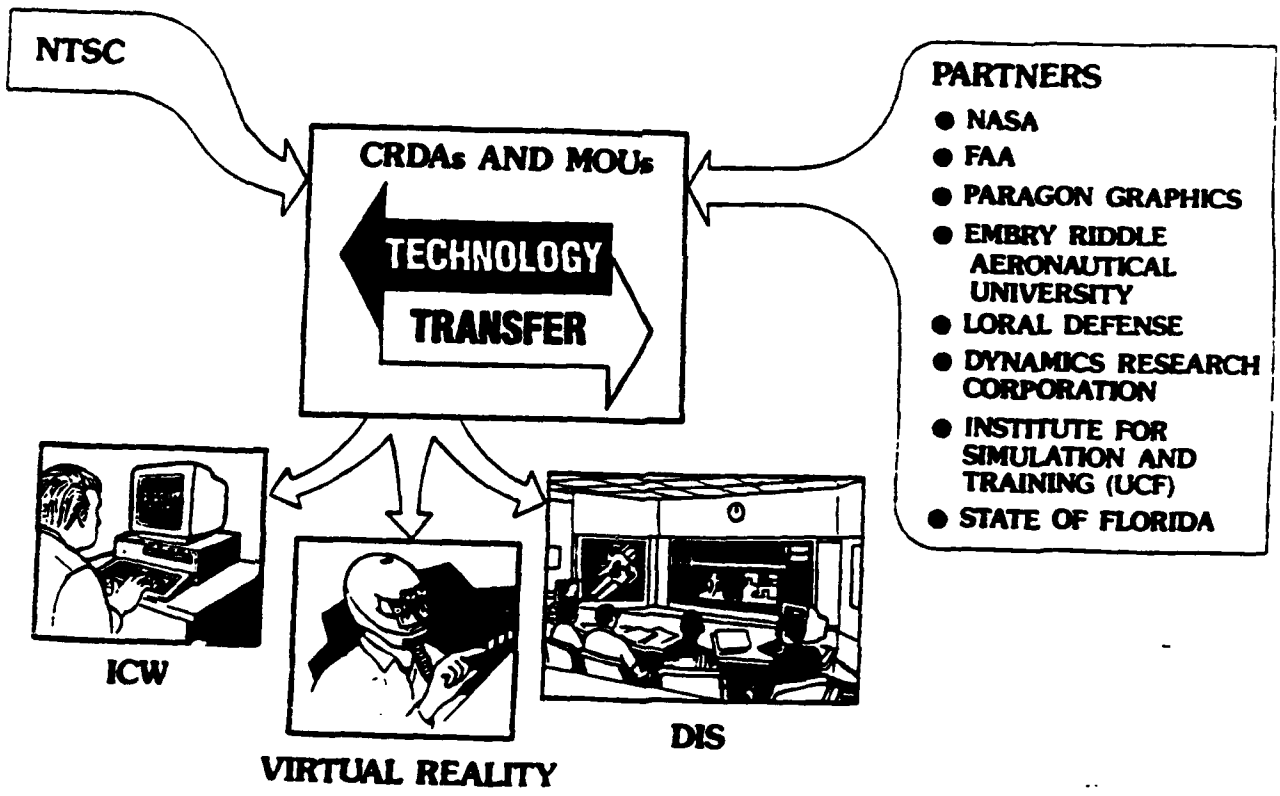
o EDGEWATER HIGH SCHOOL'S ENGINEERING CENTER - In 1991, Edgewater High School was designated an engineering educational center for high school students in Orange County Florida. The program is dedicated to increasing the number of students pursuing careers in science and engineering. Introductory as well as college level courses in engineering and science are offered at Edgewater. NAVTRASYSCEN is an advisor to this program, in addition to providing adjunct faculty, mentors, training and laboratory experiences.

o ORANGE COUNTY SHERIFF'S OFFICE - NAVTRASYSCEN is working with the Orange County Sheriff's Office to share simulation and training technology to enhance law enforcement training. In return, the Sheriff's Office is assisting with the development of a prototype Weapons Team Engagement Trainer.

BENEFITS FROM TECHNOLOGY TRANSFER

In addition to the sharing of federally funded research and enhanced commercialization of government inventions, there are other benefits from technology transfer. By sharing Navy training research with the non-DoD public sector, improvements in training and

education will occur. The benefits are not just "one way." NAVTRASYSCEN is gaining access to subject matter experts and resources. We are also learning about civilian resources which can be shared with the Navy, such as the public school's teletraining network. NAVTRASYSCEN is receiving feedback on its R&D products which can be used to improve future systems. Through the CRADA's, the Navy is gaining R&D products as well as expanding our research resources. In turn, the Nation is benefiting from new commercial products and additional employment opportunities.



APPENDIX
TERMS OF REFERENCE

ASC	Automatic Scenario Control
ASG	Automatic Scenario Generator
ATC	Afloat Training Command
ATO	Afloat Training Oranization
CASE	Computer Assisted Software Engineering
CNO	Chief of Naval Operations
CDS	Combat Direction System
CIG	Computer Image Generation
COTS	Commercial Off-the-shelf
CRADA	Cooperative Research and Development Agreement
CRT	Cathode Ray Tube
CSEDS	Combat System Engineering Development Site
DEFTT	Decision Making Evaluation Facility for Tactical Teams
DIS	Distributed Interactive Simulation
DMA	Defense Mapping Agency
DTIC	Defense Technical Information Center
DoD	Department of Defense
DTATS	Deployable Tactical Aircraft Training System
EEG	Electroencephalography
ERP	Event-related Brain Potential
EW	Electronic Warfare
ESM	Electronic Warfare Support Measures
EWCAP	Electronic Warfare Continuum Assessment Program
ET	Embedded Training
FLC	Federal Laboratories Consortium
HID	Helmet Integrated Display
HMD	Helmet Mounted Display
IR	Independent Research
IED	Independent Exploratory Development
ITS	Intelligent Tutoring System
I/ITSC	Interservice/Industry Training Systems Conference
IUSS	Integrated Undersea Surveillance System
LCD	Liquid Crystal Display
LFA	Low-frequency Active
MMI	Man-Machine Interface
NAVTRASYSCEN	Naval Training Systems Center
NCCOSC	Naval Command and Control Ocean Surveillance Center
NVG	Night Vision Goggles
PDU	Protocol Data Unit
RF	Radio Frequency
RISC	Reduced Instruction Set Computer
R&E	Research and Engineering
SBIR	Small Business Innovative Research
SpWS	Signal Processing
TACTICS	Tactical Training Instructor Components
VE	Virtual Environment